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EFFECTS OF SEEDING DATES AND SEEDING RATES ON THE AGRONOMIC CHARACTERISTICS OF RAPE (*BRASSICA NAPUS* L.)

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Effects of Seeding Dates and Seeding Rates on the Agronomic Characteristics of Rape (*Brassica napus* L.) " submitted by Delbert Frank Degenhardt in partial fulfilment of the requirements for the degree of Master of Science in Plant Breeding.

ABSTRACT

The effects of seeding date and seeding rate on the agronomic characteristics of 5 cultivars of *Brassica napus* L. were studied for 2 years at 2 locations in central Alberta. A split plot design was used with seeding dates of May 3, 17 and 31 at Edmonton and Ellerslie for mainplots. Subplots consisted of 15 treatment combinations of 5 genotypes (Oro, Turret, Midas, Altex, 74G-1382) and 3 seeding rates (3,6,12 kg/ha). Data were collected for days to initiation of elongation, first flower, last flower, maturity of first pod, maturity of last pod, and for plant height, plant density, racemes/plant, total yield, seed yield, 1000 seed weight, % seed oil, and % meal protein. Seed formation period, seed production period, flowering period, racemes/m^2 , harvest index, seed yield/plant, and vegetative yield were computed.

Significant interactions between seeding dates and treatment combinations were quite common for most of the variables studied. Seeding date effects were significant for seed yield. Generally, the latest seeding date resulted in the lowest seed yield. This was especially true of late maturing cultivars. Seeding date had a significant effect on vegetative yield. Seeding date had no consistent effect on days to 1st flower, flowering period, seed formation period and seed production period. Delayed seeding resulted in a slight decrease in days to last flower, maturity of 1st pod

and maturity of last pod. Increased seeding rate had a non-consistent effect on seed yield. Increased seeding rate resulted in a slight reduction in the days to maturity of 1st pod, seed formation and seed production time. Seeding rate had no effect on initiation of elongation, 1st flower, last flower and flowering period. Increased seeding rate resulted in decreased days to maturity of last pod, in 1976, and had no effect, in 1977. Increased seeding rate significantly increased plant density and decreased plant size (height and raceme number). The results indicated that multi-year and multi-location tests are necessary for evaluation of agronomic characteristics of *B. napus* .

Seed yield correlated significantly and positively with total yield and harvest index. A significant negative correlation between vegetative yield and seed yield or harvest index was present. Vegetative yield had a great effect on total yield and the calculated harvest index. Seed yield was positively correlated with 1000 seed wt and seed yield/plant, and negatively with plant height. Racemes/m^2 did not correlate with seed yield.

Plant density had no significant correlation with yield (seed, vegetative or total), 1000 seed wt, or plant height while having a significant negative correlation with seed yield/plant, harvest index and racemes/m^2.

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I INTRODUCTION

Rapeseed is the most important oilseed crop in Western Canada. Rapeseed was first grown commercially in Canada in 1942 to help meet wartime demands for industrial oil (Downey and Bolton, 1961). In 1942, there were 44,000 bushels produced on 3200 acres (Perkins, 1976). In 1978 rapeseed production increased to a high of 120 million bushels being produced on 6.0 million acres (Rapeseed Digest, 1978) .

Domestic rapeseed crushing has been an important factor in the rapeseed industry. Significant domestic crushing capacity began to develop about 1956 when rapeseed was first crushed as an edible oil product in Canada (Perkins, 1976). Currently, with six crushing plants operating, the Western Canadian rapeseed processing industry has the capacity to crush 3450 tons per day (41.5 million bushels annually). Rapeseed was approved for human use under the Food and Drug regulations in 1958. Subsequently, rapeseed meal was exported to Japan. Meal is used as a protein supplement in livestock feed and as a fertilizer for high-value specialty crops, e.g. tobacco and citrus fruits in Japan.

At present, rapeseed is the third most important crop in Western Canada. The prairie rapeseed acreage could be maintained at three to four million acres annually with present cultural and marketing practises.

One of the major factors leading to the acceptance and

rapid increase in rapeseed utilization has been the improvement in the oil and meal quality and in processing methods. Rapeseed oil low in erucic acid can be used as a cooking oil, in margarines and in salad dressings ,while the meal, low in glucosinolates and high in protein, can be used in livestock feed supplements. Today Canada is the world's leading rapeseed exporter and is also a leader in rapeseed research and development (Downey et al, 1974).

Seed yield per acre is of major importance to the production of any seed crop.

> Allard and Bradshaw, 1964
> "In the past the attention of practical plant breeders has centered on 'final' characters. However, plant breeders are fully aware that higher plants are dynamic living systems in which change occurs constantly from germination to maturity. The pattern of change is rarely the same from genotype to genotype in one environment or for a single genotype grown in different environments. It has been almost an article of faith from the earliest days of plant breeding that, if we only understood the development pathways by which final characters are reached, this would help us to improve the efficiency of breeding."

Yield and yield components have been extensively studied in many crops, particularly cereals. However, this

type of information is lacking for rapeseed in Canada. Selection criteria which may improve the efficiency of a plant breeding program are very important.

At present 50% of the rapeseed acreage in Western Canada is *B. napus* and 50% is *B. campestris* (Kondra, 1977b). The *B. napus* cultivars are higher yielding than *B. campestris* cultivars and produce seed which is higher in oil and protein content. The *B. napus* cultivars require approximately 10 to 14 days more to mature. With new cultivars and more agromonic knowledge, producers are looking for higher yields while the processors are looking for a higher oil content and meal higher in protein. A shorter maturity requirement in *B. napus* cultivars could aid in achieving these objectives for the producers and processors.

The seed yield and maturity of rapeseed plants can be greatly influenced by environmental conditions regardless of their genotype. Therefore, as a new cultivar is developed or introduced into a region, efficient cultural practices must be developed in order to obtain optimum profit from seed yields. The determination of the most practical seeding date and seeding rate for desired agronomic characteristics is important. With the new cultivars greater maturity differences are evident. Past research has shown the late cultivars of *B. napus* do best when seeded early but earlier cultivars may have a different optimum seeding date or a

greater seeding range. Also, the earlier cultivars might require a higher seeding rate to achieve equal seed yield for they appear to be smaller plants.

The objective of this study was to evaluate the effect of seeding date and seeding rate on yield, yield components, growth characters and gross seed quality of five genotypes of *B. napus* with a wide range of maturities. Also, correlations between the different variables were looked at. Conclusions should help both producers for commercial production and plant breeders in formulating breeding programs.

II LITERATURE REVIEW

Canadian rapeseed researchers have been concentrating their efforts on the improvement of oil and meal quality. The recently developed cultivars in both rapeseed species have been produced as a result of the need for low erucic acid content in the oil and low glucosinolate content in the meal. This low erucic acid oil is considered superior for human nutrition while low glucosinolate meal is considered superior in animal feed rations. As a result, the majority of current literature regarding rapeseed is concerned with factors of quality.

Donald (1967) stated that most plant breeding is based on defect elimination or selection for yield. He proposed that in cereal breeding one should develop a crop ideotype (model plant) and then select towards the model. This should result in new cultivars which are better adapted and more agronomically suited to growth in a monoculture. Working with a number of crops, with special reference to field beans, negative correlations between yield components of different crops was an ever present situation (Adams, 1967). Number of plants per area, number of racemes per plant, number of pods per raceme, number of seeds per pod, seed weight or any combination of the above are considered to be yield components. Adams concluded that the negative correlation meant there was a compensating characteristic in plants. That is, if there are few seeds, the seeds would be

large, or conversely, if there are many seeds, the seeds would be small. From the works of Donald with crop ideotypes and Adams with plants having a compensating relationship it becomes difficult to establish selection criteria. Selection would thus be a matter of compromising on a number of components.

Yield components

Some of the first work on yield components in rapeseed was done on *Brassica campestris* var. Yellow Sarson (Ramanujam and Rai, 1963). Total seed yield, number of pods per plant, number of seeds per pod, one thousand seed weight, number of primary branches and number of secondary branches were studied. A significant positive correlation was found between the above yield components and yield. However, a negative correlation was found to be present between any two of the yield components. This supports the idea of compensating effects in plants. Allen and Morgan (1972) demonstrated that increasing seed production of *B. napus* by nitrogen fertilization was a result of an increase in the number of pods and increased seed size.

Plants of *B. campestris* (cultivar Toria), which were grown from large seeds, produced more pods per plant, larger pods, heavier seeds and higher seed yield per plant but had fewer seeds per pod than plants from small seeds (Ahmed and Zuberi, 1973). Seed size was found to be highly variable

within cultivars of B. napus and B. campestris (Kondra, 1977a). Plants grown from large seeds generally produced large seeds. However, seed size had no consistent effect on seed yield in either species. Seed size was found to be positively related to seedling vigor but not consistently to final seed yield or yield components in both species of rapeseed (Major, 1976). The work of Major and Kondra supports the conclusion that seed sizing of rapeseed is of no economic value to producers. One thousand seed weight of B. napus was significantly affected by the plant density (Clarke, 1978b).

Total seed yield was positively correlated with number of pods per plant, number of seeds per pod and pod length for B. campestris , cultivar Toria, in a genetic study of yield and its components (Zuberi and Ahmed, 1973). Inbreeding depression was significant for number of pods per plant and total seed yield per plant. The seed yield of B. napus was significantly correlated with number of pods per plant, number of pod-bearing branches and number of pods per branch (Thurling, 1974c). Seed yield in B. napus was significantly correlated with both total dry weight of the plant at final harvest and the harvest index. The harvest index (seed wt/total wt) appeared to be the more important factor of seed yield in B. campestris. In B. napus , total dry weight accumulated in the post anthesis phase of growth was positively related to seed yield and therefore could be used as a selection criterion in breeding for higher yield

in *B. napus* (Thurling, 1974b).

A high positive correlation between vegetative yield and seed yield indicated that plant size was the major factor of seed yield per plant in *B. napus* (Campbell and Kondra, 1977). Significant positive correlations were found between yield components on a single plant basis. The number of pods on the main raceme, and number of secondary and tertiary racemes were major contributors to yield. Heterosis was present in the F_1 population for yield and yield components (Campbell and Kondra, 1978b). Heritabilities for the characters observed were generally very low and reciprocal differences were apparent.

Analysis of yield in a 10 by 10 diallel of Indian mustard (*B. juncea*) indicated that heterosis was expressed (Singh and Singh, 1972). Additive and dominant gene effects were important for primary and secondary racemes, plant height, and raceme length. Days to flower, silique length and seeds per silique indicated dominant and additive gene action. Yield was inherited mainly by dominant genetic components in Indian mustard. Heritability estimates were high for days to flower and plant height while low for branch number and length, pod length and seeds per pod. Correlation studies indicated that yield was closely positively related to days to flower, number of primary and secondary branches, plant height, main raceme length and seeds per pod.

Growth characters

The maintenance of a large and photosynthetically efficient leaf area during the period of flowering is necessary for high yield in oilseed rape (Allen and Morgan, 1972). At late anthesis defoliated plants of *B. campestris* cultivar Span produced 8.5 grams of seed per plant while non-defoliated plants produced 13.1 grams of seed per plant (Freyman *et al*, 1973) . Labelled carbon was used to further test the role of the leaves in seed formation (Major and Charnetski, 1976). Photosynthesis occurred in pods, stems and leaves of rapeseed plants exposed to ^{14}C. The roots, pods, beaks, seed apices and barren pods were all sinks (storage reserves) for assimilate products. The photosynthates moved selectively to the pods in which seeds were filling in both species with no translocation to barren pods. The lower leaves and lower portion of the stems were the primary sources of assimilates exported to the roots.

Total plant dry weight of two *B. napus* cultivars increased in a linear fashion until just before maturity (Allen and Morgan, 1972). The leaf area increased rapidly to a maximum near the onset of flowering and then decreased rapidly with only approximately 25% of the pods formed. Large increases in total dry weight were occurring when the leaf area indices (leaf area to soil area) were decreasing. This would appear to indicate that leaves have little effect on yield. Leaves may not have contributed directly to seed

development and growth of *B. campestris* and *B. napus* under irrigation (Major, 1977a). Leaves do appear to be important in determining the size of storage reserves which then may determine later development, such as the number of pods per plant. At maturity, 30-35% of the total dry weight was in seeds. The total leaf area of *B. napus* was found to have little direct effect on yield (Allen *et al*, 1971).

Analysis of growth stages and yield components of *B. napus* (three cultivars) indicated that growth characters associated with earlier maturity were associated with higher yield (Campbell and Kondra, 1978a). Correlations among growth characters were low. The correlations among growth stages indicate that earliness of initial growth stages contribute to earliness of subsequent growth stages. The cultivar Target (*B. napus*) had the earliest first flower but had a long stage from first flower to maturity (Campbell and Kondra, 1977). Target was the highest yielding cultivar.

The maturity time could be delayed in either species by the application of high levels of nitrogen fertilizer (Scott *et al*, 1973). Seed yield was obtained by cutting plants before they were fully ripe to decrease seed loss through pod shattering during swathing and combining time.

Effect of rates and dates of seeding

Seeding rate appeared to have no consistent effect on the yield of the cultivars Span (*B. campestris*) and Zephyr

(B. napus) (Kondra, 1975b). The lowest seeding rate (3 kg/ha) on the average gave the highest yield for the cultivar Span while the intermediate seeding rate (6 kg/ha) gave the highest yield for the cultivar Zephyr. A rate of 6 kg/ha if averaged over all tests, gave the best yield for both species in a subsequent experiment (Kondra, 1977a). Oil, protein and 1000 seed weight were not affected by the rate of seeding in either species.

The protein content of the seed of B. napus and B. campestris varied with dates of planting at two locations in Southern Manitoba (Gross and Stefansson, 1965). No definite trend was present : the protein increased in 1963 and decreased in 1964 with delayed seeding. Oil content was negatively associated with date of seeding.

In two out of three years, a significant negative correlation was obtained between seed yield and seeding date in B. campestris and B. napus (Gross, 1963). Yield was highest for the first seeding date in both species. Delayed seeding resulted in later maturity, reduction in plant height and reduction in time required for vegetative and reproductive development especially in the B. napus species.

Seeding date was found to have a significant effect on seed yield and growth characteristics of spring cultivars of B. campestris and B. napus (Thurling, 1974b). In B. napus, there was a significant decrease in seed yield with later seeding. This decrease in seed yield was associated

primarily with a reduction in the total dry weight of the plant at maturity. This decrease in seed yield was also closely correlated with the length of the vegetative phase of growth. The total dry weight of the plant and the seed yield were greatest in the early seeding where the period from seeding to first flower was much longer than in subsequent seedings. Thurling (1974c) supported previous work and stated that a substantial component compensation effect occurs in both species of rapeseed in regard to yield components. In B. napus, the decrease in seed yield due to successive delays in seeding was accompanied by a marked reduction in the number of pods per plant, but little change in the seed weight per pod. The yield of B. campestris was higher in the second seeding than in either the earlier or later seedings. However, there was still a substantial decrease in the number of pods per plant with delayed seeding. This decrease in the number of pods per plant was accompanied by an increase in the seed weight per pod which was substantially greater between the first and second seeding dates than between the second and third seeding date. From correlation analysis it was evident that variations in seed yield were related primarily to changes in the number of pods per plant in B. napus and to changes in seed weight per pod in B. campestris. Thurling concluded that yield component compensation in grain crops is an inevitable consequence of a limited input of metabolites to the developing inflorescence. Early seeding was also found

to give better yield in *B. napus* whether seeded in the fall or spring in Australia (Scott *et al*, 1973).

Seeding date had a significant effect on the seed yield of Midas (*B. napus*) and Torch (*B. campestris*) in central Alberta (Kondra, 1977b). The first date of seeding gave the highest seed yield in three of four tests for Midas. However, intermediate seeding date produced the highest seed yields for Torch. The highest oil and protein content was produced from the first seeding date. Delayed seeding generally resulted in a decrease in the number of days from planting to maturity for *B. campestris* and an increase for *B. napus* . A similar pattern for *B. napus* and *B. campestris* was found for seed yield and maturity in northern Alberta (Depauw, 1976). The highest oil and protein content was produced from intermediate dates of seeding. Despite the conflicting reports on optimum seeding date in *B. napus* the popular opinion seems to be that the earlier one plants in western Canada the higher the seed yield (Gross, 1963; Depauw, 1976; Kondra, 1977b; Bowren and Pittman, 1975).

III MATERIALS AND METHODS

Plant material

Three cultivars of *Brassica napus* ('Oro', 'Turret', and 'Midas') and two experimental lines from the University of Alberta breeding program ('73G-438' and 74G-1382') were used. The experimental line 73G-438 was licensed on February 28, 1978 under the cultivar name Altex (Licence number 1815). The earliest line, 74G-1382, matured in approximately 105 days. The line 73G-438 and cultivars Midas, Turret, and Oro mature in approximately 108, 112, 113, and 117 days respectively. This phenotypic expression of approximately 12 days difference from the earliest to the latest in maturity for central Alberta gave a diverse genotypic sample of *B. napus* to test.

Locations

The tests were grown at Edmonton Research Station and Ellerslie Research Station in the crop years 1976 and 1977. Previous work has indicated many differences between these 2 locations. Actual maturity differences of 3 to 5 days for material seeded on the same day is common, with Edmonton being earlier. Plant heights are usually quite different with Ellerslie having taller plants. Seed yield can vary considerably between locations on any given year. The frost free periods were: Edmonton 163 days, -3°C April 23 to -1°C

October 4, and 158 days, -3°C April 22 to -2°C September 28, for 1976 and 1977 respectively while Ellerslie had 149 days, -1°C May 6 to -3°C October 4, and 143 days, -2°C May 1 to -1°C September 23, for 1976 and 1977 respectively.

Study treatments and experimental design

A split plot randomized block experiment with four replications was used for the trials with dates of seeding being the main plots and genotypes by seeding rate combinations being the subplots. The three seeding dates were May 3, May 17 and May 31. Each genotype was seeded at 3, 6, and 12 kilogram per hectare resulting in 15 subplots. Individual plots consisted of 8 rows, 5.6 metres long, spaced 23 centimetres between rows and between plots.

Fertilizer was broadcast and worked in three days prior to seeding the first date at recommended rates of 170 and 150 kg/ha of 11-55-00 for Ellerslie in 1976 and 1977 respectively and 113.5 and 100 kg/ha of 11-55-00 for Edmonton in 1976 and 1977 respectively. Weeds were controlled in this experiment by the incorporation of Treflan herbicide at 0.5 kg/ha active ingredient in the spring 3 days prior to seeding of the first date at each location each year. Some hand weeding was done prior to the fourth true leaf stage. Plots were seeded with a Swift Current power seeder, four row cone type press drill with double disc openers, which has packing wheels before and

after the seed is placed in the soil.

Daily observations were taken to obtain the number of days to the different growth stages. The growth stage key of Campbell and Kondra (1977) was used (Table 1).

Observations, measurements or calculations were taken on the following growth, yield and seed quality parameters at both locations and in both years except for initiation of elongation which was only taken in 1976. Variables number one to eight were determined on plot material in the field. Variables number nine to twelve were determined on sample material which was harvested and bagged. Variables number thirteen to twenty are variables which were derived from the previous variables.

1. Initiation of elongation (code 3.0)

Days from seeding to initiation of elongation was recorded when visual observations determined that 75% of the plants had the first and second nodes growing apart. The rapeseed plants have between 4 and 6 fully developed leaves at this point and stem growth is about 2 to 3 cm per day after this point.

Table 1. Growth Stage Key

Code	Stage	Description
2.1	Leaf 1	Emergence of the 1st true leaf
2.3	Leaf 3	Emergence of the 3rd true leaf
2.5	Leaf 5	Emergence of the 5th true leaf
2.7	Leaf 7	Emergence of the 7th true leaf
2.9	Leaf 9	Emergence of the 9th true leaf
3.0	Initiation of elongation	Initiation of internode elongation
4.0	End elongation	Initiation of elongation of the uppermost internode on the main stem
4.1	1st flower M	1st flower on the main raceme
4.11	1st flower 1	1st flower on the 1st secondary raceme
4.12	1st flower 2	1st flower on the 2nd secondary raceme
4.13	1st flower 3	1st flower on the 3rd secondary raceme
4.14	1st flower 4	1st flower on the 4th secondary raceme
4.15	1st flower 5	1st flower on the 5th secondary raceme
4.16	1st flower 6	1st flower on the 6th secondary raceme
4.5	Last 1st flower	1st flower on the last secondary raceme to flower
5.0	last flower	Incipient petal fall of the last flower on the main raceme
5.4	Maturity of 1st pod	Seeds in the lowest pod of the main raceme all dark colored
5.5*	Maturity of last pod	Seeds in the top pod of the main raceme all dark colored

* The stage 5.5 was added. Maturity of last pod refers to the stage when the entire plant is ripe and under field conditions the material may be straight combined.

2. First flower (code 4.1)

Days from seeding to first flower was recorded when 75% of the plants had at least three open flowers on the main raceme.

3. Last flower (code 5.0)

Days from seeding to last flower was recorded when 75% of the plants appeared to have terminated flowering on the main raceme.

4. Maturity of first pod(code 5.4)

Days from seeding to maturity of the first pod was recorded when the majority of the plants had all black seeds in the lowest pod of the main raceme.

5. Maturity of the last pod (code 5,5)

Days from seeding to maturity of the last pod of the main raceme was noted after the sample area for yield was removed. The sample for yield was harvested prior to maturity of last pod to reduce seed shattering lost at harvest. Maturity of the last pod was determined on the square metre area directly behind the harvested area which was still within the original plot area. The seeds were black in the pods at the top of the main raceme at this stage.

6. Plant height

Plant height in centimetres was determined by two measurements within each plot when the plants were at the growth stage of maturity of first pod (code 5.4).

7. Plant density

Plant density was determined by counting the number of plants in one square metre of the plot. The counts were done one day prior to the harvesting date.

8. Racemes per plant

The number of racemes per 10 plants was determined on 5 plants of each of the center two rows directly behind the harvested area. A raceme was defined as any raceme with at least one pod.

9. Total yield

Total yield per 2 square metres was defined as the vegetative yield plus the seed yield. An area of two square metres was cut at the ground level from the center four rows by 2 metres of each plot with a sickle. The samples were air dried in cotton bags after cutting until two days prior to threshing at which time they were put in forced air driers at approximately 35°C for two days.

10. Seed yield

The seed yield per 2 square metres in grams of each plot was determined from the total yield sample. An Almaco Plot Thresher, rub-bar type was used.

11. 1000 seed weight

Thousand seed weight in grams was obtained by determining the weight of 500 seeds from each seed yield sample.

12. Per cent seed oil

The percent oil of the whole seed was obtained by analysis of a 26 gram sample from each seed yield sample by a Newport, Nuclear Magnetic Resonance Analyzer (NMR).

13. Per cent meal protein

The 26 gram sample used for oil analysis was ground in a coffee grinder with the addition of dry ice. The ground sample was then analyzed in a Neotec, Grain Quality Analyzer (GQA model 31) for protein on a whole seed basis. The % meal protein was then calculated by using the % oil and the % protein of the seed.

$$\% \text{ meal protein} = \frac{\% \text{ seed protein}}{100 - \% \text{ seed oil}} \times 100$$

14. Seed formation period (4.10 to 5.4)

The seed formation period is the number of days from first flower to maturity of first pod.

15. Seed production period (4.10 to 5.5)

The seed production period is the number of days from first flower to maturity of the last pod.

16. Flowering period (4.10 to 5.0)

The number of days of flowering was calculated as the period from first flower to last flower on the main raceme.

17. Racemes per square metre

The number of raceme per square metre was calculated from the number of racemes per plant and the plant density.

18. Harvest index

The harvest index was obtained by dividing the seed yield by the total yield.

19. Seed yield per plant

The seed yield per plant in grams was calculated from the seed yield per plot and the plant density.

20. Vegetative yield

The vegetative yield per 2 square metres in grams was calculated by taking the difference between total yield and seed yield.

Analysis of data

1. Analysis of Variance (ANOVA)

The data were analyzed as a split plot with seeding dates as the main plots and seeding rates by genotype combinations as subplots on all variables studied. Locations and years were treated as separate experiments.

Source of Variation	Degrees of Freedom	F-value .05	F-value .01
replication	3		
main plots	2	5.14	10.92
main plot error	6		
subplots	14	1.77	2.23
interaction	28	1.55	1.85
subplot error	126		
total	179		

Days to different growth stages and growth periods were not analyzed on a treament combination basis by analysis of variance since no differences between replicates were observed. Least significant difference of P=0.05 was the statistical method used to show differences among date means, among rate means and among genotype means.

2. <u>Correlations</u>

Pearson correlation coefficients were calculated between nineteen variables for all data. The data were also analyzed in different subsets. The data was analyzed over replications, rates, genotypes, dates, locations, and years for correlation of *B. napus* as a species. Also, the data were analyzed on the 5 genotypes separately across replications, rate, dates, locations and years to see genotype differences within the *B. napus* species.

IV RESULTS AND DISCUSSION

Part A Analysis of Variance

Seeding dates , at Edmonton , had a significant effect on all variables except total yield in 1976 and racemes/plant and % meal protein in 1977 (Table 2). Seeding dates at Ellerslie had a significant effect on all variables except % meal protein, harvest index, racemes/m², and seed yield/plant in 1976 and plant density and racemes/m² in 1977.

At both locations in both years, significant differences were observed in all variables studied due to different subplot treatment combinations (genotypes by seeding rate) except total yield at Edmonton 1977 (Table 2). Interactions (date by treatment) over both years and locations were consistently significant for only 1000 seed weight. No interactions were present for seed yield, vegetative yield and racemes per plant over both years and locations. Analysis of variance indicated that there were significant differences among genotypes when averaged across dates, locations and years for all variables except total yield, racemes/m², seed formation period and seed production period (Table 3).

Table 2. Split plot analysis of variance

Variables	Locations	Main plots dates 1976	Main plots dates 1977	Subplots treatment 1976	Subplots treatment 1977	Interaction date by treatment 1976	Interaction date by treatment 1977
seed yield	Edmonton	**	**	**	**	-	-
	Ellerslie	*	**	**	**	-	-
vegetative yield	Edmonton	*	**	**	**	-	-
	Ellerslie	*	**	**	**	-	-
total yield	Edmonton	-	*	**	-	-	-
	Ellerslie	**	**	**	**	*	-
harvest index	Edmonton	**	**	**	**	**	-
	Ellerslie	-	**	**	**	-	**
seed yield per plant	Edmonton	**	**	**	**	*	-
	Ellerslie	-	**	**	**	-	-
1000 seed wt	Edmonton	**	**	**	**	**	**
	Ellerslie	**	**	**	**	**	**
plant density	Edmonton	**	**	**	**	**	*
	Ellerslie	*	-	**	**	*	-
racemes per plant	Edmonton	**	-	**	**	-	-
	Ellerslie	*	*	**	**	-	-
racemes per m^2	Edmonton	**	**	**	**	**	-
	Ellerslie	-	-	*	**	-	-
plant height	Edmonton	**	**	**	**	-	-
	Ellerslie	**	**	**	**	**	**
% seed oil	Edmonton	*	**	**	**	**	-
	Ellerslie	**	**	**	**	-	**
% meal protein	Edmonton	**	-	**	**	**	-
	Ellerslie	-	**	**	**	-	-

**, * significant at the 1% and 5% level respectively

Table 3. Genotype means for all variables

(Averaged over all replications, seeding rates and dates, locations and years) (n=144)

	Oro	Turret	Midas	74G-1382	73G-438
seed yield g	400a	480b	472b	485b	479b
vegetative yield g	1322b	1252ab	1224ab	1116a	1161ab
total yield g	1722a	1732a	1696a	1601a	1640a
harvest index	.237a	.281ab	.282ab	.308b	.296b
seed yield per plant g	2.29a	3.21b	3.15ab	3.06ab	3.31b
1000 seed wt g	3.16a	3.59b	3.40ab	4.11c	3.39ab
plant density m^2	123b	104ab	93a	110ab	106ab
racemes per plant	3.8ab	4.1bc	4.4c	3.6a	4.1bc
racemes per m^2	413a	373a	384a	350a	381a
plant height cm	129c	114b	117b	100a	110b
% seed oil	38.2a	42.5c	41.0b	40.9b	40.9b
% meal protein	41.9a	42.7ab	43.3b	45.3c	45.8c

* values within the row followed by the same letter are not significantly different at .05 level, LSD.

Table 3. Genotype means for all variables (continued)

(Averaged over all replications, seeding rates and dates, locations and years) (n=144)

	Oro	Turret	Midas	74G-1382	73G-438
initiation of elongation (days)**	39.1e	38.2c	38.6d	35.7a	37.3b
1st flower (days)	56.3c	50.5b	51.5b	44.9a	48.5b
last flower (days)	77.6d	71.2bc	73.4c	64.3a	68.8b
maturity of 1st pod (days)	113d	108c	107bc	100a	103ab
maturity of last pod (days)	122c	117b	116b	109a	111a
flowering period (days)	21.3ab	20.7ab	21.9b	19.4a	20.3ab
seed formation period (days)	57.1a	57.1a	55.2a	55.0a	54.2a
seed production period (days)	66.0a	66.7a	64.8a	63.6a	62.9a

* values within the row followed by the same letter are not significantly different at .05 level, LSD.
** averaged for 1976 only, n=72.

Seed yield

Delayed seeding resulted in a significant increase in seed yield between the 1st and 2nd seeding date with a non-significant increase between the 2nd and 3rd seeding date averaged over all treatments for Edmonton 1976 (Table 4). Delayed seeding resulted in a significant decrease in seed yield between the 1st and 3rd seeding date in Edmonton 1977, and Ellerslie 1976 and 1977 (Table 4 and 5). The effect of date of seeding on early and late maturing genotypes were similar within locations for seed yield.

Seeding date had a non-consistent effect on seed yield when all experiments were considered. Overall averages agree with previous work in the western provinces which indicate that the earlier one seeds *B. napus* the higher the seed yield (Kondra 1977b, Pittman 1975, Depauw 1976, Gross 1963). In central Alberta, early seeding of *B. napus* not only averages higher seed yield but eliminates the high risk of frost damage which may occur in the fall. All genotypes showed large seed yield reduction with late seeding in 1977. Since no consistent effects were present one would require multi-year and multi-location testing to determine better genotypes.

Rate of seeding showed no significant effect in any of the station years on seed yield (Table 6). The middle rate of seeding appeared better at Ellerslie both years but was non-significant. Overall averages agree with the previous

Table 4. Effects of seeding date, seeding rate and genotype on seed yield (grams/2m²) 1976

		Edmonton			Ellerslie		
	Rate	Date of seeding*			Date of seeding*		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	403	438	411	438	387	384
Oro	6	398	492	494	396	421	373
Oro	12	394	479	480	454	367	382
Oro means		398a	470a	462a	429a	391a	380a
Turret	3	408	465	488	469	450	432
Turret	6	475	488	529	536	510	501
Turret	12	467	506	568	390	470	480
Turret means		450b	486ab	528b	465ab	477b	471b
Midas	3	458	442	428	512	437	431
Midas	6	469	488	550	458	518	447
Midas	12	423	504	535	529	444	477
Midas means		450b	478ab	504ab	500b	466b	452b
74G-1382	3	440	466	449	485	398	425
74G-1382	6	455	506	456	566	510	503
74G-1382	12	438	474	482	435	521	392
74G-1382 means		444b	482ab	462a	495ab	476b	440b
73G- 438	3	491	474	478	482	479	497
73G- 438	6	476	518	490	509	531	486
73G- 438	12	515	561	504	391	448	472
73G- 438 means		494c	518b	490ab	461ab	486b	485b
Date means+		447a	487b	489b	470b	459ab	445a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				73		92	
Between Any Other Two Treatment Means, LSD 5%.				72		89	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
\+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 5. Effects of seeding date, seeding rate and genotype on seed yield (grams/2m²) 1977

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	581	397	257	562	492	266
Oro	6	537	339	191	481	506	187
Oro	12	466	295	188	448	429	193
Oro means		528a	343a	212a	497a	476a	215a
Turret	3	564	516	387	553	537	361
Turret	6	520	492	329	569	577	352
Turret	12	576	548	369	593	530	291
Turret means		553a	518b	362b	572bc	548a	335b
Midas	3	562	458	343	525	506	373
Midas	6	553	511	386	539	562	345
Midas	12	512	445	334	543	584	360
Midas means		542a	471b	354b	535ab	550a	359b
74G-1382	3	636	561	344	615	534	403
74G-1382	6	538	570	401	596	588	394
74G-1382	12	575	527	321	643	498	326
74G-1382 means		583a	552b	355b	618c	540a	374b
73G- 438	3	537	458	419	494	541	381
73G- 438	6	531	500	373	573	574	394
73G- 438	12	494	530	395	464	504	280
73G- 438 means		520a	496b	395b	510ab	539a	351b
Date means+		545c	476b	336a	546b	531b	327a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				119		114	
Between Any Other Two Treatment Means, LSD 5%.				116		123	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 6. Effect of seeding rates on seed yield at 4 station years (grams/$2m^2$)

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	449a	486a	488a
Ellerslie	447a	484a	443a
1977			
Edmonton	468a	451a	438a
Ellerslie	476a	482a	446a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

work at the University of Alberta that the middle seeding rate resulted in higher seed yield (Kondra, 1975b).

Oro had signigicantly lower seed yields than the other genotypes when averaged over all treatments (Table 3). Although the experimental lines were considerably earlier in maturity they maintained a high yield relative to the other later maturity types. The early maturity would be an advantage to the producers in central and northern Alberta who have to compete with the elements to harvest a sound crop.

Vegetative yield

Date of seeding had a significant effect on vegetative yield in 1976 at both locations. The highest vegetative yield was produced from the second date of seeding at Edmonton and the first date at Ellerslie in 1976 (Table 7). Delayed seeding resulted in significant increases in vegetative yield among all three seeding dates in 1977 at both locations (Table 8). Seeding date effects on vegetative yield were similar for each genotype at the same station year.

Seeding rate resulted in no significant difference in 3 of the 4 station years for vegetative yield (Table 9). A significant positive effect on vegetative yield between the 3 and 12 kg/ha seeding rate was observed at Edmonton 1976.

Table 7. Effects of seeding date, seeding rate and genotype on vegetative yield (grams/2m²) 1976

		Edmonton			Ellerslie		
	Rate	Date of seeding*			Date of seeding*		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	997	1059	982	1120	1024	1103
Oro	6	1027	1106	1149	1104	1147	1104
Oro	12	1038	1146	1177	1242	1206	1113
Oro means		1021ab	1104b	1103c	1155ab	1125a	1107b
Turret	3	947	943	987	1158	1032	1056
Turret	6	994	1137	1087	1227	1171	1155
Turret	12	1060	1154	1177	1078	1178	1190
Turret means		1001ab	1078b	1083c	1154ab	1127a	1133b
Midas	3	1026	999	919	1185	1013	1057
Midas	6	1082	1078	973	1100	1122	1058
Midas	12	977	1139	1035	1237	1108	1146
Midas means		1028b	1072b	976b	1174b	1081a	1087b
74G-1382	3	910	856	803	1125	774	848
74G-1382	6	943	994	842	1284	1165	1027
74G-1382	12	950	973	888	1105	1217	893
74G-1382 means		934a	941a	884a	1171b	1052a	923a
73G- 438	3	989	834	918	1051	993	1001
73G- 438	6	944	1017	880	1094	1141	1006
73G- 438	12	1018	1145	924	962	1140	1103
73G- 438 means		984ab	998ab	907ab	1035a	1091a	1037b
Date means+		993ab	1038b	982a	1137b	1095ab	1057a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				144.4		173.1	
Between Any Other Two Treatment Means, LSD 5%.				143.2		172.8	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
\+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 8. Effects of seeding date, seeding rate and genotype on vegetative yield (grams/$2m^2$) 1977

		Edmonton			Ellerslie		
	Rate	Date of seeding*			Date of seeding*		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	1457	1447	1787	1294	1564	2022
Oro	6	1444	1495	1622	1213	1644	1851
Oro	12	1478	1418	1893	1196	1434	1488
Oro means		1459b	1453b	1767b	1234c	1547d	1787b
Turret	3	1317	1318	1588	1091	1407	1608
Turret	6	1199	1340	1471	1143	1480	1586
Turret	12	1218	1546	1787	1182	1339	1734
Turret means		1245a	1401b	1615ab	1139b	1409c	1642ab
Midas	3	1226	1324	1507	1163	1301	1665
Midas	6	1309	1377	1633	1193	1376	1230
Midas	12	1175	1386	1616	1158	1410	1759
Midas means		1237a	1362ab	1585ab	1171bc	1362bc	1551ab
74G-1382	3	1158	1064	1312	954	1279	1516
74G-1382	6	1019	1368	1475	967	1162	1656
74G-1382	12	1176	1236	1473	1026	1152	1568
74G-1382 means		1118a	1223a	1420a	982a	1198a	1580ab
73G- 438	3	1176	1267	1438	1100	1246	1356
73G- 438	6	1163	1457	1490	1215	1320	1551
73G- 438	12	1107	1377	1706	1062	1178	1439
73G- 438 means		1149a	1367ab	1544ab	1125b	1248ab	1449a
Date means+		1241a	1361b	1586c	1130a	1352b	1601c
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				285.2		242.3	
Between Any Other Two Treatment Means, LSD 5%.				283.3		238.8	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 9. Effect of seeding rates on vegetative yield at 4 station years (grams/2m²)

Locations	Rate of Seeding*		
	3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	945a	1017ab	1054b
Ellerslie	1036a	1127a	1128a
1977			
Edmonton	1359a	1391a	1439a
Ellerslie	1371a	1372a	1342a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Genotype means within seeding dates were significantly different in 11 out of 12 comparisons (Tables 7 and 8). Line 74G-1382 resulted in the lowest vegetative yield while Oro was significantly higher on the average (Table 3). Vegetative yield does not appear to indicate seed yield or if indicating seed yield it would be in a negative direction for the rankings of genotypes were opposite with the line 74G-1382 being significantly higher seed yielding than the cultivar Oro. However, the material used in this study might bias the results in this direction. The vegetative yield was affected much more than the seed yield by date of seeding. The last date of seeding in 1977 at both locations produced a tremendous increase in vegetative yield while a tremendous drop in seed yield occurred. On a single plant basis it was found that vegetative yield had a positive relationship with seed yield (Campbell and Kondra, 1977). The work of this study indicated a negative relationship between rankings of vegetative yield and seed yield on a plot basis.

Total yield

Delayed seeding resulted in a significant decrease in total yield among the three seeding dates at Ellerslie 1976 while the total yield increased significantly between 1st and 2nd seeding date but decreased a non-significant amount between the 2nd and 3rd seeding date at Edmonton 1976 (Table 10). Total yield increased significantly in 1977 between the 1st and 3rd seeding dates at both locations (Table 11). The

Table 10. Effects of seeding date, seeding rate and genotype on total yield (grams/2m²) 1976

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	1400	1498	1393	1558	1410	1487
Oro	6	1425	1598	1642	1500	1567	1477
Oro	12	1432	1625	1657	1695	1572	1495
Oro means		1419a	1573b	1564c	1584a	1517a	1487ab
Turret	3	1355	1408	1475	1627	1482	1487
Turret	6	1470	1625	1615	1762	1680	1655
Turret	12	1527	1660	1745	1467	1647	1670
Turret means		1451a	1564ab	1612c	1619a	1603a	1604b
Midas	3	1484	1440	1347	1697	1450	1487
Midas	6	1551	1566	1522	1557	1640	1505
Midas	12	1400	1642	1570	1764	1552	1622
Midas means		1478a	1550ab	1480bc	1673a	1548a	1538b
74G-1382	3	1350	1322	1253	1610	1172	1272
74G-1382	6	1398	1500	1298	1850	1675	1530
74G-1382	12	1388	1447	1370	1540	1737	1285
74G-1382 means		1378a	1423a	1307a	1667a	1528a	1363a
73G- 438	3	1480	1308	1395	1532	1472	1497
73G- 438	6	1420	1535	1370	1602	1672	1492
73G- 438	12	1532	1705	1427	1352	1587	1575
73G- 438 means		1478a	1516ab	1398ab	1496a	1578a	1522b
Date means+		1441a	1525b	1472ab	1608c	1555b	1503a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				203		251	
Between Any Other Two Treatment Means, LSD 5%.				206		243	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 11. Effects of seeding date, seeding rate and genotype on total yield (grams/2m²) 1977

		Edmonton			Ellerslie		
	Rate	Date of seeding*			Date of seeding*		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	2038	1844	2044	1856	2056	2288
Oro	6	1981	1834	1813	1694	2150	2038
Oro	12	1944	1713	2081	1644	1863	1681
Oro means		1988b	1797a	1979a	1731a	2023c	2002a
Turret	3	1881	1834	1975	1644	1944	1969
Turret	6	1719	1831	1800	1713	2056	1938
Turret	12	1794	2094	2156	1775	1869	2025
Turret means		1798ab	1920a	1977a	1710a	1956bc	1977a
Midas	3	1788	1781	1850	1688	1806	2038
Midas	6	1863	1888	2019	1731	1938	1575
Midas	12	1688	1831	1950	1700	1993	2119
Midas means		1779ab	1833a	1940a	1706a	1913abc	1910a
74G-1382	3	1794	1625	1656	1569	1813	1919
74G-1382	6	1556	1938	1875	1563	1750	2050
74G-1382	12	1751	1763	1794	1669	1650	1894
74G-1382 means		1700a	1775a	1775a	1600a	1738a	1954a
73G- 438	3	1713	1725	1856	1594	1788	1738
73G- 438	6	1694	1956	1863	1788	1894	1944
73G- 438	12	1600	1906	2100	1525	1681	1719
73G- 438 means		1669a	1863a	1940a	1635a	1788ab	1800a
Date means⁺		1786a	1837a	1922b	1676a	1883b	1928b
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				370		313	
Between Any Other Two Treatment Means, LSD 5%.				365		323	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 12. Effect of seeding rates on total yield at 4 station years (grams/2m²)

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	1394a	1502ab	1542b
Ellerslie	1483a	1611a	1571a
1977			
Edmonton	1827a	1842a	1878a
Ellerslie	1847a	1854a	1787a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

work of Thurling in Australia found a decrease in total dry weight with delayed seeding while over all averages from this study would indicate the opposite (Thurling, 1974c). An observation was that the cool wet weather in 1977 resulted in greater total yield regardless of seeding date . Therefore, the contradiction between the two studies was probably due to drier conditions with delayed seeding in Australia.

Increased seeding rate resulted in a non-significant increase in total yield in 3 out of 4 station years (Table 12). There was a significant increase in total yield in 1976 at Edmonton between the 3 and 12 kg/ha rate of seeding. Three genotypes resulted in the middle rate of seeding being significantly greater in total yield at Ellerslie 1976 while two genotypes showed the same trend as the averages of the Edmonton location (Tables 10 and 11). In conclusion, seeding rate had no consistent effect on total yield. Over all means for total yield indicated no significant difference between genotypes (Table 3).

Harvest Index

Delayed seeding had a significant positive effect on the harvest index between the 1st or 2nd and the 3rd date at Edmonton 1976 while having no significant effect at Ellerslie 1976 (Table 13). Delayed seeding resulted in a significant decrease in harvest index at both locations in

1977 among all three seeding dates (Table 14). Delayed seeding had a significant positive effect on harvest indices for the earliest maturing genotype (74G-1382) in 1976 but had a significant negative effect in 1977 (Tables 13 and 14). The early maturing genotypes (74G-1382 and 73G-438) had significantly higher harvest indices and higher seed yield than the late cultivar (Oro) in all comparisons between genotype means within dates.

Increased seeding rate resulted in no significant difference in harvest index for Edmonton 1976, 1977 and Ellerslie 1977 while an increased seeding rate from 6 to 12 kg/ha produced a significant decrease in the harvest index for Ellerslie 1976 (Table 15).

It would appear that the harvest index was not a good indicator of seed yield. Early maturing lines had significantly higher harvest indices than Oro but the other two cultivars were not significantly higher than Oro (Tables 3, 13 and 14). Oro was significantly lower seed yielding than the other 4 genotypes. The high harvest indices could be due to the low vegetative yield of the early maturing lines. It was found that both total yield and harvest index had a positive relationship with seed yield (Thurling, 1974a). Also, on a single plant basis, plant size was related to seed yield (Campbell and Kondra, 1977). However, harvest index would not appear to be a promising evaluation criterion for eliminating lines in a <u>B. napus</u> breeding

Table 13. Effects of seeding date, seeding rate and genotype on harvest index 1976

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	.290	.292	.292	.282	.272	.258
Oro	6	.277	.308	.303	.265	.267	.250
Oro	12	.275	.295	.287	.267	.233	.255
Oro means		.281a	.298a	.294a	.272a	.258a	.254a
Turret	3	.302	.332	.332	.290	.303	.290
Turret	6	.322	.300	.330	.303	.303	.300
Turret	12	.308	.305	.327	.267	.285	.290
Turret means		.311bc	.313a	.330b	.287ab	.297b	.293b
Midas	3	.310	.308	.317	.303	.303	.290
Midas	6	.302	.312	.363	.292	.315	.297
Midas	12	.302	.308	.340	.297	.287	.295
Midas means		.305b	.309a	.340bc	.298bc	.302b	.294b
74G-1382	3	.325	.355	.357	.303	.340	.332
74G-1382	6	.327	.337	.352	.308	.305	.327
74G-1382	12	.315	.327	.350	.282	.300	.302
74G-1382 means		.323c	.340b	.353c	.298bc	.315b	.321c
73G- 438	3	.332	.363	.342	.313	.325	.330
73G- 438	6	.337	.337	.360	.315	.317	.327
73G- 438	12	.337	.330	.355	.290	.285	.297
73G- 438 means		.336d	.343b	.353c	.306c	.309b	.318c
Date means+		.311a	.321ab	.334c	.292a	.296a	.296a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				.024		.025	
Between Any Other Two Treatment Means, LSD 5%.				.024		.025	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
\+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 14. Effects of seeding date, seeding rate and genotype on harvest index 1977

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	.284	.215	.125	.303	.238	.114
Oro	6	.270	.185	.105	.284	.236	.092
Oro	12	.341	.171	.085	.273	.230	.105
Oro means		.265a	.190a	.105a	.287a	.235a	.104a
Turret	3	.300	.280	.196	.338	.276	.183
Turret	6	.302	.269	.184	.332	.281	.180
Turret	12	.320	.258	.173	.334	.283	.145
Turret means		.308b	.269b	.184b	.335c	.280b	.170b
Midas	3	.313	.257	.187	.309	.278	.182
Midas	6	.297	.269	.189	.310	.287	.227
Midas	12	.304	.242	.171	.315	.292	.172
Midas means		.305b	.256b	.183b	.311b	.286b	.194b
74G-1382	3	.357	.345	.209	.390	.294	.210
74G-1382	6	.345	.295	.215	.381	.335	.192
74G-1382	12	.329	.298	.179	.386	.301	.170
74G-1382 means		.344c	.313c	.201b	.386d	.310c	.191b
73G- 438	3	.314	.266	.227	.309	.303	.224
73G- 438	6	.315	.254	.201	.320	.303	.202
73G- 438	12	.308	.271	.189	.303	.295	.159
73G- 438 means		.312b	.263b	.206b	.311b	.300bc	.195b
Date means+		.307c	.258b	.176a	.326c	.282b	.170a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				.038		.044	
Between Any Other Two Treatment Means, LSD 5%.				.o38		.046	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 15. Effect of seeding rates on harvest index at 4 station years

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	.323a	.325a	.318a
Ellerslie	.302a	.300a	.282b
1977			
Edmonton	.258a	.246a	.236a
Ellerslie	.263a	.264a	.251a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

program because of the impact that the vegetative yield has on the harvest index.

Seed yield per plant

Delayed seeding resulted in a significant difference in seed yield per plant but these differences did not rank in the same order at either location in either year (Tables 16 and 17).

Increased seeding rate resulted in a significant drop in seed yield per plant at both locations in both years (Table 18).

Significant genotype differences were present when averaged over all locations and years (Table 3). The line 73G-438 and the cultivar Turret had significantly higher seed yield per plant than the cultivar Oro. The ranking of the lowest and highest genotypes were not consistent especially between the different years (Tables 16 and 17).

1000 seed weight

The 3rd seeding date resulted in larger seeds than the second at both locations in 1976 (Table 19). By contrast, the 2nd seeding date had larger seeds than the 3rd date of seeding at both locations in 1977 (Table 20). The 1st seeding date resulted in a significantly higher 1000 seed wt than the 2nd and 3rd seeding date at Ellerslie 1976. One

Table 16. Effects of seeding date, seeding rate and genotype on seed yield per plant (grams) 1976

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	3.70	4.41	5.45	5.27	3.49	5.89
Oro	6	2.50	2.54	3.43	2.71	1.87	2.21
Oro	12	1.21	1.77	1.75	1.40	1.13	1.15
Oro means		2.47a	2.90ab	3.54a	3.13a	2.16a	3.08a
Turret	3	3.75	3.78	6.87	4.35	3.55	3.66
Turret	6	2.84	2.63	4.38	2.51	2.22	2.49
Turret	12	1.27	1.48	2.44	0.81	1.04	1.53
Turret means		2.62a	2.63a	4.56ab	2.56a	2.27a	2.56a
Midas	3	5.20	4.94	6.37	5.49	4.73	4.51
Midas	6	3.37	3.45	6.82	2.85	2.98	3.13
Midas	12	1.64	2.18	4.25	1.64	1.39	1.64
Midas means		3.40a	3.50ab	5.81bc	3.33a	3.03a	3.09a
74G-1382	3	5.36	5.99	6.13	5.49	5.29	4.67
74G-1382	6	2.40	3.15	4.31	3.65	2.74	3.42
74G-1382	12	1.26	1.55	1.89	1.11	1.19	1.31
74G-1382 means		3.00a	3.56a	4.11ab	3.42a	3.07a	3.14a
73G- 438	3	5.91	6.59	10.23	5.55	4.36	5.35
73G- 438	6	2.89	3.98	7.12	4.27	2.48	3.24
73G- 438	12	1.59	2.42	5.29	1.81	1.28	1.88
73G- 438 means		3.46a	4.33b	7.55c	3.88a	2.70a	3.49a
Date means+		2.99a	3.39b	5.11c	3.26c	2.65a	3.07b
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.			.844			.879	
Between Any Other Two Treatment Means, LSD 5%.			.887			.885	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 17. Effects of seeding date, seeding rate and genotype on seed yield per plant (grams) 1977

		Edmonton			Ellerslie		
	Rate	Date of seeding*			Date of seeding*		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	4.40	2.20	2.10	4.13	2.79	1.71
Oro	6	2.01	1.29	1.15	1.35	1.62	0.60
Oro	12	1.18	0.61	0.82	1.08	1.16	0.45
Oro means		2.53a	1.37a	1.36a	2.18a	1.86a	0.92a
Turret	3	7.09	5.07	7.02	5.93	5.87	3.25
Turret	6	4.68	2.91	3.29	2.13	2.99	1.99
Turret	12	2.69	1.81	2.81	1.98	1.85	0.72
Turret means		4.82b	3.26c	4.37c	3.34a	3.57b	1.98b
Midas	3	4.06	2.81	3.40	3.32	2.88	2.24
Midas	6	2.72	2.12	2.62	2.30	2.95	1.37
Midas	12	3.05	1.96	3.08	2.76	1.80	1.24
Midas means		3.28a	2.30abc	3.04b	2.79a	2.54ab	1.62ab
74G-1382	3	5.07	4.69	4.31	4.25	5.43	3.07
74G-1382	6	2.74	2.80	2.43	2.64	2.55	1.60
74G-1382	12	1.58	1.09	1.08	1.75	1.25	0.83
74G-1382 means		3.13a	2.86bc	2.61b	2.88a	3.08ab	1.83b
73G- 438	3	5.54	2.52	3.52	2.46	3.36	3.09
73G- 438	6	2.32	2.02	3.00	2.31	2.88	1.61
73G- 438	12	1.63	1.30	2.24	1.20	1.36	0.60
73G- 438 means		3.16a	1.95ab	2.92b	1.99a	2.53ab	1.76ab
Date means+		3.39c	2.34a	2.86b	2.64b	2.71b	1.62a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				1.30		1.16	
Between Any Other Two Treatment Means, LSD 5%.				1.32		1.18	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
\+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 18. Effect of seeding rates on seed yield per plant at 4 station years (grams)

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	5.64c	3.72b	2.13a
Ellerslie	4.78c	2.85b	1.35a
1977			
Edmonton	4.25c	2.54b	1.80a
Ellerslie	3.58c	2.06b	1.33a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 19. Effects of seeding date, seeding rate and genotype on 1000 seed weight (grams) 1976

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	3.20	2.97	3.02	3.00	2.81	2.75
Oro	6	3.12	3.18	3.09	2.96	2.77	2.69
Oro	12	3.13	3.10	3.21	2.96	2.87	2.66
Oro means		3.15b	3.08a	3.11a	2.97a	2.82a	2.70a
Turret	3	3.37	3.13	3.81	3.61	3.35	3.31
Turret	6	3.58	3.44	3.67	3.70	3.16	3.30
Turret	12	3.51	3.27	3.63	3.13	3.19	3.31
Turret means		3.49c	3.28b	3.70c	3.48b	3.23c	3.30c
Midas	3	3.29	3.02	3.14	3.23	2.95	2.90
Midas	6	3.24	3.31	3.61	3.51	3.03	2.93
Midas	12	3.25	3.43	3.52	3.36	3.02	3.19
Midas means		3.26b	3.25b	3.42b	3.37b	3.00b	3.00b
74G-1382	3	3.89	4.10	4.45	4.15	3.67	4.12
74G-1382	6	3.93	4.01	4.43	4.09	3.88	4.06
74G-1382	12	4.04	4.03	4.08	3.98	3.87	3.99
74G-1382 means		3.95d	4.05c	4.32d	4.07c	3.81d	4.06d
73G- 438	3	2.93	3.05	3.56	3.01	2.77	3.13
73G- 438	6	2.91	3.18	3.58	2.92	2.67	3.14
73G- 438	12	3.10	3.18	3.63	2.95	2.66	3.16
73G- 438 means		2.98a	3.14ab	3.59bc	2.96a	2.70a	3.14b
Date means+		3.37a	3.36a	3.63b	3.37c	3.11a	3.24b
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				.25		.27	
Between Any Other Two Treatment Means, LSD 5%.				.25		.27	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
\+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 20. Effects of seeding date, seeding rate and genotype on 1000 seed weight (grams) 1977

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	3.47	3.59	3.10	3.52	3.24	3.02
Oro	6	3.55	3.59	3.25	3.41	3.35	3.10
Oro	12	3.33	3.43	3.25	3.35	3.34	3.27
Oro means		3.45a	3.54a	3.20a	3.43a	3.31a	3.13a
Turret	3	3.86	4.05	3.45	3.95	3.95	3.26
Turret	6	3.81	3.97	3.43	4.01	3.93	3.37
Turret	12	3.66	4.17	3.61	3.91	3.92	3.44
Turret means		3.78c	4.06c	3.50c	3.96c	3.94d	3.36b
Midas	3	3.63	3.86	3.31	3.67	3.53	3.21
Midas	6	3.58	4.02	3.46	3.69	3.54	3.50
Midas	12	3.54	3.80	3.35	3.71	3.67	3.28
Midas means		3.59b	3.89b	3.38b	3.69b	3.58b	3.33b
74G-1382	3	4.24	4.49	3.96	4.14	4.31	3.93
74G-1382	6	4.35	4.31	3.84	4.35	4.22	3.94
74G-1382	12	4.36	4.35	3.94	4.44	4.13	3.76
74G-1382 means		4.32d	4.38d	3.91e	4.31d	4.22e	3.88c
73G- 438	3	3.60	3.82	3.68	3.68	3.69	3.35
73G- 438	6	3.93	3.83	3.58	3.67	3.79	3.61
73G- 438	12	3.92	3.86	3.72	3.61	3.69	3.42
73G- 438 means		3.82c	3.83b	3.66d	3.65b	3.72c	3.46b
Date means+		3.79b	3.94c	3.53a	3.81b	3.75b	3.43a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				.23		.21	
Between Any Other Two Treatment Means, LSD 5%.				.22		.23	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 21. Effect of seeding rates on 1000 seed weight at 4 station years (grams)

Locations	Rate of Seeding*		
	3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	3.40a	3.48a	3.47a
Ellerslie	3.25a	3.25a	3.22a
1977			
Edmonton	3.74a	3.77a	3.75a
Ellerslie	3.63a	3.70a	3.66a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

thousand seed wt was the only variable with a consistently significant date by treatment interaction at all station years (Table 2). Seed size would appear to be a very changeable character which is affected greatly by the environment which agrees with the conclusion of Clarke *et al.* (1978b) who stated that the environment had a significant effect on seed size. Seed size was found to be highly variable within cultivars of *B. napus* and *B. campestris* (Kondra, 1977a).

The rate of seeding resulted in no significant differences for 1000 seed wt at either location in either year (Table 21). This agrees with previous work that found 1000 seed wt not significantly affected by seeding rate (Gross, 1963 and Kondra, 1975b). The middle rate of seeding had the highest 1000 seed wt at both locations in both years.

There were significant differences between the different cultivars, with Oro's 1000 seed wt being 1.0 gram lower than that of the line 74G-1382 at both locations in both years. The earliest maturing genotype, 74G-1382, had a significantly higher 1000 seed wt than any of the other genotypes on overall averages (Table 3). The 1000 seed wt appeared to be one of the major components of yield, since the line 74G-1382 had high seed yield and large seeds while the cultivar Oro had low seed yield and small seeds. The 1000 seed wt was not a good predictor of yield for the

rankings of genotypes was different from seed yield rankings.

Plant density

Delayed seeding resulted in a significantly lower plant density at the 3rd seeding date at Edmonton in 1976 and 1977 (Table 22 and 23). Ellerslie had a significantly lower plant density for the 3rd than the 2nd seeding date in 1976 but in 1977 there was no significant difference in the plant density at the different seeding dates. This may have been the result of good soil moisture for the last date at Ellerslie 1977. Delayed seeding resulted in the lowest plant density at the 3rd seeding date in 3 out of 4 station years. There was no consistent effect between the 1st and 2nd date of seeding and plant density.

Increased rate of seeding resulted in a significant increased plant density among all three seeding rates at all station years (Table 24). A 2 fold increase in seeding from 3 to 6 kg/ha resulted in a 1.7 fold increase in 1976 and 1.6 fold increase in 1977 at Edmonton in actual plant density. At Ellerslie, a 2 fold increase from 3 to 6 kg/ha resulted in 1.8 fold increase in 1976 and 1.7 fold increase in 1977 in plant density. A 2 fold increase from 6 to 12 kg/ha resulted in 1.9 fold increase in 1976 at both locations and 1.6 fold increase at Edmonton and 1.5 fold increase at Ellerslie in 1977. These results indicate that the

Table 22. Effects of seeding date, seeding rate and genotype on plant density (m^2) 1976

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	56	50	38	45	56	47
Oro	6	81	99	72	77	114	87
Oro	12	162	139	138	167	172	171
Oro means		100a	96a	83b	96a	114a	102a
Turret	3	56	63	38	57	63	60
Turret	6	84	94	62	111	116	100
Turret	12	185	172	124	248	233	165
Turret means		109a	110a	75b	139a	138a	109a
Midas	3	46	45	35	48	54	48
Midas	6	71	73	42	86	89	72
Midas	12	130	120	76	165	163	151
Midas means		83a	79a	51ab	100a	102a	90a
74G-1382	3	45	41	38	46	40	47
74G-1382	6	97	81	57	82	94	75
74G-1382	12	176	153	129	199	223	151
74G-1382 means		106a	92a	75b	109a	119a	91a
73G- 438	3	43	37	25	46	55	56
73G- 438	6	83	68	41	76	110	76
73G- 438	12	163	124	54	131	181	129
73G- 438 means		96a	77a	40a	85a	115a	87a
Date means+		99b	91b	65a	106ab	118bc	96a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				21.6		32.8	
Between Any Other Two Treatment Means, LSD 5%.				22.8		33.5	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
\+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 23. Effects of seeding date, seeding rate and genotype on plant density (m²) 1977

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	69	95	63	79	100	86
Oro	6	138	146	91	189	161	159
Oro	12	205	240	180	226	198	237
Oro means		137c	160a	111c	165b	153a	161a
Turret	3	41	52	28	52	47	56
Turret	6	57	88	55	137	103	90
Turret	12	111	160	72	177	154	214
Turret means		70a	100a	51a	122ab	101a	120a
Midas	3	71	85	57	86	88	88
Midas	6	104	125	78	123	105	142
Midas	12	90	115	56	100	174	161
Midas means		88ab	108a	64ab	103a	122a	130a
74G-1382	3	63	62	45	72	51	69
74G-1382	6	102	110	83	115	120	126
74G-1382	12	184	246	152	187	202	199
74G-1382 means		116bc	139a	93bc	125ab	124a	131a
73G- 438	3	52	95	62	101	83	60
73G- 438	6	119	125	71	129	104	123
73G- 438	12	163	260	95	217	208	244
73G- 438 means		111bc	160a	76abc	149ab	132a	142a
Date means+		105b	133c	79a	133a	126a	137a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				44.4		54.2	
Between Any Other Two Treatment Means, LSD 5%.				46.4		53.8	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 24. Effect of seeding rates on plant density at 4 station years (m^2)

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	44a	74b	137c
Ellerslie	51a	91b	177c
1977			
Edmonton	63a	99b	155c
Ellerslie	74a	128b	193c

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

competition mortality rate was not higher at the higher seeding rate than at the lower seeding rate. A four fold increase from 3 to 12 kg/ha resulted in an increase of 3.1 fold Edmonton 1976, 3.4 fold Ellerslie 1976, 2.5 fold Edmonton 1977 and 2.6 fold Ellerslie 1977. Emergence and plant survival appeared to be unpredictable for the different seeding rates for the genotypes studied.

Genotype means within dates were significantly different in regards to plant densities in 4 out of 12 comparisons (Tables 22 and 23). Turret on the average had the highest plant density in 1976 while Oro had the highest plant density in 1977. This may be due to a date by treatment interaction which was present in 3 out of 4 station years (Table 2). Midas had the lowest plant density both years. The line 73G-438 also had a low plant density in 1976. Over all averages indicate that the cultivar Oro had a significantly higher plant density than the cultivar Midas (Table 3). This could have been the result of 1000 seed weights being different. The largest 1000 seed wt , however, was 74G-1382 and it did not have the lowest plant density. The soil and competition differences may cause the differences in mortality of the different genotypes and thus affect plant density.

Racemes per plant

The 2nd seeding date resulted in a significantly lower number of racemes per plant than the 1st seeding date at

both locations in 1976 (Tables 25). There was no significant difference between seeding dates at Edmonton in 1977 while the 3rd seeding date was significantly lower than the 1st and 2nd seeding date for Ellerslie 1977 (Table 26).

Increased seeding rate, which resulted in an increased plant density, resulted in significantly fewer racemes/plant at both locations in 1976 and significantly fewer racemes/plant between the 3 and 6 or 12 kg/ha seeding rate in 1977 at both locations (Table 27). Also, the number of racemes/plant had a direct relationship with seed yield/plant. Plants with more racemes had more seed yield.

There were significant differences between genotype means within dates for 9 out of 12 comparisons. The line 74G-1382 had significantly lower number of racemes on the average than the cultivars Turret and Midas and the line 73G-438 (Table 3) and yet the line 74G-1382 had the highest seed yield. Overall averages indicated that the cultivar Midas had significantly more racemes/plant than the line 74G-1382 and the cultivar Oro. This indicates that raceme number is not directly related to seed yield since both the line 74G-1382 and the cultivar Oro had a low raceme number per plant.

Racemes per square metre

Delayed seeding resulted in a significant decrease in the number of racemes per square metre between all three

Table 25. Effects of seeding date, seeding rate and genotype on number of racemes per plant 1976

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	6.1	5.2	5.1	5.8	5.1	5.3
Oro	6	4.8	3.9	3.8	4.3	3.5	3.8
Oro	12	3.7	3.1	3.0	3.9	2.6	3.1
Oro means		4.9b	4.0abc	4.0ab	4.6ab	3.7ab	4.1a
Turret	3	4.9	4.6	5.3	4.5	3.9	4.7
Turret	6	3.8	4.0	4.1	4.4	4.0	4.6
Turret	12	2.9	3.2	3.6	2.9	2.3	2.4
Turret means		3.9a	3.9ab	4.3abc	3.9a	3.4a	3.9a
Midas	3	5.8	5.5	5.1	5.8	5.0	5.0
Midas	6	5.2	4.8	4.8	5.0	4.7	4.8
Midas	12	4.5	4.0	4.1	4.0	3.3	3.0
Midas means		5.1b	4.8c	4.7bc	4.9b	4.3b	4.3a
74G-1382	3	4.9	4.7	4.3	4.9	4.3	4.3
74G-1382	6	3.7	3.4	4.0	4.0	3.2	3.5
74G-1382	12	2.9	3.2	2.9	3.1	2.9	2.6
74G-1382 means		3.8a	3.7a	3.7a	4.0a	3.5ab	3.4a
73G- 438	3	6.0	5.6	5.7	5.5	5.1	4.8
73G- 438	6	4.3	4.5	4.9	4.2	3.9	3.9
73G- 438	12	4.2	3.8	4.2	3.3	2.8	3.4
73G- 438 means		4.8b	4.6bc	4.9c	4.3ab	3.9ab	4.0a
Date means+		4.5b	4.2a	4.3ab	4.4b	3.8a	3.9ab
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				.69		.81	
Between Any Other Two Treatment Means, LSD 5%.				.67		.82	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 26. Effects of seeding date, seeding rate and genotype on number of racemes per plant 1977

		Edmonton			Ellerslie		
	Rate	Date of seeding*			Date of seeding*		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	4.0	4.1	4.9	4.6	4.3	4.1
Oro	6	3.3	2.7	3.3	2.9	3.1	2.5
Oro	12	2.7	3.1	2.6	2.8	2.8	2.8
Oro means		3.3a	3.3ab	3.6a	3.4a	3.4a	3.1a
Turret	3	5.5	4.6	6.6	5.0	5.0	4.2
Turret	6	4.8	3.9	4.6	4.3	4.1	2.9
Turret	12	3.9	3.3	4.7	3.7	3.5	2.4
Turret means		4.7b	3.9bc	5.3b	4.3b	4.2a	3.2a
Midas	3	4.2	4.7	4.3	5.1	4.3	4.0
Midas	6	3.7	3.7	3.5	4.6	4.2	3.2
Midas	12	4.5	4.2	5.0	4.5	3.3	3.4
Midas means		4.1ab	4.2c	4.3ab	4.7b	3.9a	3.5a
74G-1382	3	4.6	3.9	5.2	4.1	4.6	4.5
74G-1382	6	2.9	3.2	3.7	3.1	3.4	3.1
74G-1382	12	2.0	2.5	2.6	2.7	2.7	3.1
74G-1382 means		3.2a	3.2a	3.8a	3.3a	3.6a	3.6a
73G- 438	3	5.6	3.9	4.1	5.1	4.2	4.2
73G- 438	6	3.6	3.0	4.4	4.3	3.9	3.5
73G- 438	12	3.1	2.4	3.8	2.7	2.7	2.7
73G- 438 means		4.1ab	3.1a	4.1a	4.0ab	3.6a	3.4a
Date means+		3.9a	3.5a	4.2a	3.9b	3.7b	3.4a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				12.3		9.8	
Between Any Other Two Treatment Means, LSD 5%.				13.4		10.0	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
\+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 27. Effect of seeding rates on number of racemes per plant at 4 station years

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	5.2c	4.3b	3.5a
Ellerslie	4.9c	4.1b	3.0a
1977			
Edmonton	4.7b	3.6a	3.4a
Ellerslie	4.5b	3.5a	3.2a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

seeding dates at Edmonton 1976 and between the 1st and 3rd seeding dates at Ellerslie in 1976 and 1977 (Tables 28 and 29). Racemes/m² were significantly lower for the 1st than the 2nd seeding date and the 3rd seeding date significantly lower than the 1st seeding date at Edmonton 1977.

Increased seeding rate resulted in a significant increase in the number of racemes per unit area in all station years except between the 3 and 6 kg/ha seeding rate at Edmonton 1977 (Table 30). The seeding rate of 12 kg/ha resulted in a significantly greater number of racemes/m² at both locations in both years.

Genotype means within dates were not significantly different in 5 out of 6 comparisons 1976 and in 3 out of 6 comparisons 1977 (Tables 28 and 29). The average of all rates, dates, locations and years indicated no significant differences among genotypes for racemes per unit area (Table 3).

Plant height

Delayed seeding resulted in significantly shorter plants at Ellerslie in 1976 and between the 1st or 2nd and 3rd seeding date at Edmonton in 1976 but delayed seeding resulted in significantly taller plants in 1977 at both locations (Tables 31 and 32). The Ellerslie location had a significant interaction between the date of seeding and treatment combinations for plant height (Table 2). The

Table 28. Effects of seeding date, seeding rate and genotype on number of racemes/m² 1976

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	343	258	195	262	287	255
Oro	6	391	377	273	323	396	332
Oro	12	606	417	403	659	455	541
Oro means		447a	351a	291b	415a	379a	376a
Turret	3	279	283	203	254	246	281
Turret	6	319	371	258	492	464	464
Turret	12	532	550	442	724	535	380
Turret means		377a	401a	301b	490a	415a	375a
Midas	3	274	246	177	274	278	241
Midas	6	363	347	201	430	419	343
Midas	12	580	476	313	644	531	447
Midas means		405a	356a	230ab	449a	409a	344a
74G-1382	3	223	190	165	227	173	201
74G-1382	6	357	275	222	330	299	261
74G-1382	12	510	482	367	619	654	385
74G-1382 means		363a	316a	251ab	392a	375a	282a
73G- 438	3	253	208	140	261	278	274
73G- 438	6	357	301	190	328	425	293
73G- 438	12	680	471	224	432	499	424
73G- 438 means		430a	327a	186a	341a	401a	330a
Date means+		404c	350b	252a	417b	396ab	342a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				107.5		151.2	
Between Any Other Two Treatment Means, LSD 5%.				112.2		154.4	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 29. Effects of seeding date, seeding rate and genotype on number of racemes/m² 1977

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	273	379	307	343	418	336
Oro	6	437	381	277	520	488	403
Oro	12	569	748	454	594	521	632
Oro means		426b	503a	346b	486ab	476a	457a
Turret	3	219	232	177	257	235	232
Turret	6	269	341	235	571	414	262
Turret	12	423	517	329	651	513	486
Turret means		303a	363a	247a	493ab	387a	327a
Midas	3	301	407	234	435	367	329
Midas	6	387	448	276	566	429	432
Midas	12	393	476	276	428	547	523
Midas means		360ab	444a	262ab	476ab	448a	428a
74G-1382	3	289	236	216	296	232	309
74G-1382	6	289	334	305	355	409	380
74G-1382	12	370	605	401	493	523	610
74G-1382 means		316ab	391a	307ab	381a	388a	433a
73G- 438	3	289	356	263	518	342	243
73G- 438	6	425	374	309	556	398	431
73G- 438	12	482	585	346	574	563	631
73G- 438 means		399ab	438a	306ab	549b	435a	435a
Date means+		361b	428c	294a	477b	427a	416a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				153.6		166.8	
Between Any Other Two Treatment Means, LSD 5%.				152.5		168.2	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
\+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 30. Effect of seeding rates on number of racemes/m^2 at 4 station years

Locations	Rate of Seeding*		
	3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	229a	307b	470c
Ellerslie	253a	373b	529c
1977			
Edmonton	278a	339a	465b
Ellerslie	326a	441b	553c

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 31. Effects of seeding date, seeding rate and genotype on plant height (centimetres) 1976

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	122	136	118	156	146	130
Oro	6	125	127	118	149	139	127
Oro	12	119	126	114	145	134	125
Oro means		122d	130d	117d	150d	140d	127d
Turret	3	109	114	107	135	129	122
Turret	6	116	113	101	129	122	116
Turret	12	110	112	103	117	118	113
Turret means		112bc	113bc	104bc	127b	123bc	117bc
Midas	3	122	116	112	142	130	121
Midas	6	117	116	103	135	129	118
Midas	12	112	118	104	130	120	119
Midas means		117cd	117c	107c	136c	127c	119c
74G-1382	3	101	97	87	116	106	102
74G-1382	6	97	98	85	109	110	103
74G-1382	12	97	93	89	104	107	99
74G-1382 means		98a	96a	87a	110a	108a	102a
73G- 438	3	105	105	104	132	122	115
73G- 438	6	110	110	102	127	119	117
73G- 438	12	108	111	99	120	120	107
73G- 438 means		108b	109b	102b	127b	120b	113b
Date means+		111b	113b	103a	130c	124b	116a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				10.5		6.9	
Between Any Other Two Treatment Means, LSD 5%.				10.8		7.5	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 32. Effects of seeding date, seeding rate and genotype on plant height (centimetres) 1977

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	109	137	143	121	145	142
Oro	6	102	125	140	116	132	136
Oro	12	100	122	129	110	127	136
Oro means		103c	128c	137d	116c	135d	138d
Turret	3	96	120	122	115	115	127
Turret	6	93	113	122	104	116	126
Turret	12	90	111	117	99	111	127
Turret means		93b	115b	120bc	106b	114c	127c
Midas	3	96	120	126	110	112	134
Midas	6	96	111	123	110	110	130
Midas	12	96	116	127	107	111	123
Midas means		96b	116b	125c	109b	111bc	129c
74G-1382	3	84	110	113	97	107	105
74G-1382	6	82	104	108	89	104	116
74G-1382	12	77	98	107	90	99	110
74G-1382 means		81a	104a	107a	92a	103a	110a
73G- 438	3	94	114	118	96	110	122
73G- 438	6	94	111	120	93	110	118
73G- 438	12	91	109	115	90	107	114
73G- 438 means		93b	112b	117b	93a	109b	118b
Date means+		93a	114b	121c	103a	114b	124c
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				7.6		7.2	
Between Any Other Two Treatment Means, LSD 5%.				8.2		7.8	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 33. Effect of seeding rates on plant height at 4 station years (centimetres)

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	110a	109a	108a
Ellerslie	127c	123b	119a
1977			
Edmonton	113b	109ab	107a
Ellerslie	117b	114ab	111a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

temperature, rainfall and light may be the key factors affecting plant height.

Increased seeding rate between 3 and 12 kg/ha resulted in significantly shorter plants in 3 out of 4 station years (Table 33). Since increased seeding rate resulted in a greater plant density and shorter plants, one may conclude that more competition results in shorter plants.

Genotype differences were quite large, the later maturing cultivars were significantly taller than the earlier maturing line at both locations in both years (Tables 31 and 32). Ellerslie plots were taller than Edmonton plots both years for the same seeding date. An interesting observation is that ranked heights of genotypes indicated order of maturity except for Turret. This again could be the result of the genotypes used for this study. The line 74G-1382 was significantly shorter than other genotypes while the cultivar Oro was significantly taller than other genotypes over all (Table 3).

Per cent seed oil

Date of seeding had a significant but non-consistent effect on the per cent oil of the seed from location to location or from year to year (Tables 34 and 35). This disagrees with the previous work that found a consistent negative relationship between seeding date and % seed oil (Gross, 1963 and Kondra, 1977b).

Table 34. Effects of seeding date, seeding rate and genotype on per cent seed oil 1976

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	39.3	38.7	39.4	38.2	38.8	38.8
Oro	6	39.7	38.2	40.3	37.8	38.3	38.8
Oro	12	37.9	37.8	40.1	38.0	37.7	38.9
Oro means		39.0a	38.2a	39.9a	38.0a	38.3a	38.8a
Turret	3	44.3	42.0	44.3	43.6	43.7	43.1
Turret	6	43.4	43.0	43.6	42.4	42.3	42.6
Turret	12	44.2	42.1	43.5	40.7	42.4	43.5
Turret means		44.0c	42.4c	43.8d	42.3c	42.8c	43.1c
Midas	3	41.9	40.3	40.7	41.1	40.9	40.3
Midas	6	42.4	40.2	43.4	41.0	41.8	41.4
Midas	12	41.6	40.1	42.2	41.4	42.2	42.0
Midas means		42.0b	40.2b	42.1c	41.2b	41.6b	41.2b
74G-1382	3	42.7	41.6	41.5	41.1	41.1	42.4
74G-1382	6	42.3	41.6	41.3	40.5	42.2	41.1
74G-1382	12	43.2	41.9	40.9	40.3	41.3	41.3
74G-1382 means		42.7b	41.7c	41.2b	40.6b	41.5b	41.6b
73G- 438	3	42.0	41.1	43.3	40.9	41.9	42.4
73G- 438	6	41.8	42.6	42.8	40.7	41.0	42.0
73G- 438	12	42.4	41.8	43.6	39.0	40.2	42.2
73G- 438 means		42.1b	41.8c	43.2d	40.2b	41.0b	42.2bc
Date means+		41.9b	40.9a	42.1b	40.4a	41.1b	41.4b
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				1.51		1.69	
Between Any Other Two Treatment Means, LSD 5%.				1.66		1.66	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
\+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 35. Effects of seeding date, seeding rate and genotype on per cent seed oil 1977

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	37.8	37.4	36.8	37.7	37.9	38.5
Oro	6	36.4	37.7	39.3	37.0	38.2	38.4
Oro	12	37.9	35.6	39.6	37.5	37.8	38.8
Oro means		37.4a	36.9a	38.6a	37.4a	37.9a	38.6a
Turret	3	42.7	41.6	42.9	42.8	42.9	42.1
Turret	6	42.5	40.9	42.2	42.6	41.7	41.1
Turret	12	42.2	41.3	42.3	42.3	42.0	40.0
Turret means		42.5c	41.2c	42.4c	42.5c	42.2c	41.1c
Midas	3	40.9	40.1	42.0	40.4	39.9	41.2
Midas	6	40.6	39.9	41.9	40.8	40.0	40.0
Midas	12	40.8	39.8	43.1	40.7	40.2	41.2
Midas means		40.7b	39.9b	42.3c	40.6b	40.0b	40.8c
74G-1382	3	40.7	39.2	41.2	41.4	41.9	39.6
74G-1382	6	41.2	39.0	40.7	42.7	39.2	38.9
74G-1382	12	40.2	38.6	40.1	41.9	39.6	38.1
74G-1382 means		40.7b	38.9b	40.7b	42.0c	40.2b	38.9a
73G- 438	3	39.4	40.1	42.6	41.3	40.2	40.4
73G- 438	6	40.4	38.3	41.8	39.9	39.3	40.2
73G- 438	12	39.2	38.8	41.5	40.2	40.2	38.9
73G- 438 means		39.7b	39.0b	41.9bc	40.5b	39.9b	39.8b
Date means+		40.2b	39.2a	41.2c	40.6b	40.1a	39.8a
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				2.24		1.48	
Between Any Other Two Treatment Means, LSD 5%.				2.20		1.46	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 36. Effect of seeding rates on per cent seed oil at 4 station years

Locations	Rate of Seeding*		
	3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	41.5a	41.8a	41.6a
Ellerslie	41.2a	40.9a	40.7a
1977			
Edmonton	40.4a	40.2a	40.0a
Ellerslie	40.5a	40.0a	40.0a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Seeding rate had a non-significant effect on % seed oil (Table 36). This agrees with previous work on the two rapeseed species (Kondra, 1975b). The lower seeding rate resulted in slightly higher oil in 3 out of 4 station years.

Genotype differences were common with Turret being significantly higher in 8 out of 12 comparisons than the other genotypes within seeding dates for oil while Oro was significantly lower in oil than the other genotypes in 11 out of 12 comparisons (Tables 34 and 35). The genotypic differences were consistent with genotypes having the same relative ranking from date to date. Overall averages resulted in Turret being significantly higher in oil and Oro significantly lower in oil than the other genotypes (Table 3). The accurate ranking of lines, in a breeding program, for % seed oil should be possible.

Per cent meal protein

The actual % seed protein is not as important as the % meal protein since rapeseed sells as two commodities oil and meal. The meal price is affected by the meal protein content.

Dates of seeding had a significant effect on % meal protein (Tables 37 and 38). The first date was lower on the average but the results were not consistent from location to location or year to year. Previous work, also, found that % meal protein was affected by seeding date but no definite

Table 37. Effects of seeding date, seeding rate and genotype on per cent meal protein 1976

		Edmonton			Ellerslie		
	Rate	Date of seeding*			Date of seeding*		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	39.7	41.2	42.6	42.2	41.3	42.1
Oro	6	39.3	41.4	42.8	42.2	40.9	41.4
Oro	12	39.6	41.9	41.6	41.3	41.4	40.7
Oro means		39.5a	41.5a	42.3a	41.9ab	41.2a	41.4a
Turret	3	38.4	41.6	42.9	43.7	42.3	42.0
Turret	6	38.8	41.5	42.8	42.6	42.0	42.3
Turret	12	39.1	41.3	42.8	42.1	40.6	41.4
Turret means		38.8a	41.5a	42.8a	42.8b	41.7a	41.9a
Midas	3	37.4	40.6	41.6	41.4	40.1	42.2
Midas	6	38.8	40.0	42.3	42.1	39.7	41.4
Midas	12	38.3	41.1	42.3	41.3	41.9	41.6
Midas means		38.2a	40.6a	42.1a	41.6a	40.6a	41.8a
74G-1382	3	42.2	45.0	45.8	43.4	43.6	44.6
74G-1382	6	40.7	43.4	47.5	44.6	44.7	46.5
74G-1382	12	40.3	44.6	47.9	45.1	43.5	45.2
74G-1382 means		41.0b	44.3b	47.1b	44.4c	43.9b	45.5b
73G- 438	3	43.3	45.0	46.7	44.3	44.0	45.8
73G- 438	6	39.8	44.8	46.6	44.9	44.1	46.3
73G- 438	12	40.8	43.8	47.1	45.7	45.7	47.1
73G- 438 means		41.3b	44.6b	46.8b	45.0c	44.6b	46.4b
Date means+		39.8a	42.5b	44.2c	43.1b	42.4a	43.4b
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				1.81		1.72	
Between Any Other Two Treatment Means, LSD 5%.				1.91		1.80	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
\+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 38. Effects of seeding date, seeding rate and genotype on per cent meal protein 1977

Genotype	Rate kg/ha	Edmonton Date of seeding* 1st	2nd	3rd	Ellerslie Date of seeding* 1st	2nd	3rd
Oro	3	41.3	43.3	40.3	41.9	41.3	42.5
Oro	6	40.4	43.5	42.6	42.1	42.2	43.2
Oro	12	41.1	47.2	43.2	42.1	41.7	43.8
Oro means		41.0a	44.7b	42.0a	42.0a	41.7a	43.2ab
Turret	3	42.9	44.6	42.3	43.9	44.0	43.2
Turret	6	43.3	45.0	42.8	44.3	44.1	44.1
Turret	12	43.9	46.3	44.2	43.5	45.0	44.9
Turret means		43.3b	45.3bc	43.1a	43.9b	44.4b	44.1b
Midas	3	41.4	41.8	41.6	41.5	43.3	42.9
Midas	6	41.5	41.5	42.7	41.1	42.7	42.5
Midas	12	41.5	43.6	42.1	41.6	44.3	43.3
Midas means		41.5a	42.3a	42.1a	41.4a	43.4b	42.9a
74G-1382	3	46.8	46.4	46.3	45.7	46.6	46.2
74G-1382	6	44.1	47.1	46.1	46.0	45.9	46.8
74G-1382	12	46.4	45.9	46.3	45.8	46.0	46.7
74G-1382 means		45.8c	46.5bc	46.2b	45.8c	46.2c	46.6c
73G- 438	3	46.3	46.7	45.9	45.7	45.3	45.4
73G- 438	6	47.2	47.1	46.4	46.4	46.3	46.9
73G- 438	12	47.5	47.5	47.4	47.4	47.5	48.0
73G- 438 means		47.0c	47.1c	46.6b	46.5c	46.4c	46.7c
Date means+		43.7a	45.2b	44.0ab	43.9a	44.4b	44.7b
Between Two Subplot Means in Any One Main Plot Level, LSD 5%.				2.58		1.60	
Between Any Other Two Treatment Means, LSD 5%.				2.70		1.56	

* genotype comparisons within seeding dates, followed by the same letter are not significantly different at LSD 5% level.
+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 39. Effect of seeding rates on per cent meal protein at 4 station years

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	42.3a	42.0a	42.2a
Ellerslie	42.9a	43.1a	43.0a
1977			
Edmonton	43.8a	44.1a	44.9a
Ellerslie	43.9a	44.3a	44.8a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

trend was present (Gross, 1963 and Kondra, 1977b).

Seeding rate had no significant effect on the % meal protein at either of the locations in either year (Table 39). Seeding rate was found not to affect % meal protein (Kondra, 1975b).

Genotype means within dates were significantly different, with the two experimental lines from the University of Alberta breeding program being significantly higher in meal protein than the other three cultivars in 11 out of 12 comparisons (Tables 37 and 38). Overall averages showed the cultivar Oro to be significantly lower than Midas, 73G-438 and 74G-1382 and the early maturing lines, 74G-1382 and 73G-438, to be significantly higher than the three cultivars for % meal protein (Table 3). Meal protein contents were consistent in their ranking among genotypes within dates, locations and years so one should be able to give a rank to an experimental line.

<u>Initiation of elongation</u> (code 3.0)

Delayed seeding resulted in a significant decrease in days to initiation of elongation at Edmonton in 1976 while delayed seeding between the 1st and 2nd or 3rd seeding date at Ellerslie in 1977 resulted in a decrease in days to initiation of elongation (Table 40). However, the decrease was not nearly enough to compensate for the delay of 14 days between dates of seedings.

Table 40. Effects of seeding date, seeding rate and genotype on days to initiation of elongation 1976

Genotype	Rate kg/ha	Edmonton Date of seeding 1st	2nd	3rd	Ellerslie Date of seeding 1st	2nd	3rd
Oro	3	40	40	38	42	36	39
Oro	6	40	40	38	42	36	39
Oro	12	40	40	38	42	36	38
Oro means		40	40	38	42	36	39
Turret	3	40	39	37	40	36	37
Turret	6	40	39	37	40	36	37
Turret	12	40	39	37	40	36	37
Turret means		40	39	37	40	36	37
Midas	3	42	39	37	42	37	35
Midas	6	42	39	37	42	37	35
Midas	12	42	39	37	42	37	35
Midas means		42	39	37	42	37	35
74G-1382	3	37	36	34	38	35	34
74G-1382	6	37	36	34	38	35	34
74G-1382	12	37	36	34	38	35	34
74G-1382 means		37	36	34	38	35	34
73G- 438	3	39	38	36	39	36	36
73G- 438	6	39	38	36	39	36	36
73G- 438	12	39	38	36	39	36	36
73G- 438 means		39	38	36	39	36	36
Date means+		39.6c	38.5b	36.4a	40.2c	36.0a	36.2b

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Rate of seeding had no significant effect on days to initiation of elongation at either location in 1976 (Table 41). Genotype differences were present, with 74G-1382 having the shortest period to initiation of elongation (Table 40). The early lines were showing indications of being early maturing at this point at both locations, while the cultivars were not showing indications of their relative ranking for maturity. For this reason initiation of elongation was not studied in 1977. Initiation of elongation may be affected largely by the soil temperature which increases thru the month of May.

First flower (code 4.1)

Delayed seeding resulted in a significant decrease in days to first flower among all three seeding dates at both locations in 1976 and Edmonton in 1977 (Table 42 & 43). In 1977 at Ellerslie there was a significant decrease between the 1st and 2nd seeding date while a significant but small increase between the 2nd and 3rd seeding date. Therefore, on the average delayed seeding did result in a consistent shortening of the length of days to 1st flower. It may be that environmental factors other than the length of daylight affect flowering in all the genotypes in this study.

Increased seeding rate resulted in no significant change at either location in either year (Table 44).

There were large differences between genotypes in

Table 41. Effect of seeding rates on days to initiation of elongation at 2 station years

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	38.2a	38.2a	38.2a
Ellerslie	37.5a	37.4a	37.4a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 42. Effects of seeding date, seeding rate and genotype on days to first flower 1976

Genotype	Rate kg/ha	Edmonton Date of seeding 1st	2nd	3rd	Ellerslie Date of seeding 1st	2nd	3rd
Oro	3	61	58	52	65	59	53
Oro	6	61	58	52	65	59	52
Oro	12	61	58	52	65	58	52
Oro means		61	58	52	65	59	52
Turret	3	57	52	49	59	53	50
Turret	6	57	52	49	58	53	50
Turret	12	57	52	49	59	52	50
Turret means		57	52	49	59	53	50
Midas	3	59	53	51	60	54	50
Midas	6	58	53	50	59	54	50
Midas	12	58	53	49	59	53	50
Midas means		58	53	50	59	54	50
74G-1382	3	48	48	43	51	49	45
74G-1382	6	48	48	43	51	49	45
74G-1382	12	48	48	43	51	49	45
74G-1382 means		48	48	43	51	49	45
73G- 438	3	53	51	47	55	51	49
73G- 438	6	52	51	47	55	51	49
73G- 438	12	52	50	47	55	51	49
73G- 438 means		52	51	47	55	51	49
Date means+		55.3c	52.4b	48.1a	57.8c	52.9b	49.1a

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 43. Effects of seeding date, seeding rate and genotype on days to first flower 1977

Genotype	Rate kg/ha	Edmonton Date of seeding 1st	2nd	3rd	Ellerslie Date of seeding 1st	2nd	3rd
Oro	3	56	53	53	58	54	55
Oro	6	56	53	53	58	54	55
Oro	12	56	53	53	58	54	55
Oro means		56	53	53	58	54	55
Turret	3	52	45	45	53	46	46
Turret	6	52	45	45	53	46	46
Turret	12	52	45	45	53	46	46
Turret means		52	45	45	53	46	46
Midas	3	53	46	46	55	47	47
Midas	6	53	46	46	55	47	47
Midas	12	53	46	46	55	47	47
Midas means		53	46	46	55	47	47
74G-1382	3	47	39	39	48	41	41
74G-1382	6	47	39	39	48	41	41
74G-1382	12	47	39	39	48	41	41
74G-1382 means		47	39	39	48	41	41
73G- 438	3	50	44	43	50	45	45
73G- 438	6	50	44	43	50	45	45
73G- 438	12	50	44	43	50	45	45
73G- 438 means		50	44	43	50	45	45
Date means+		51.6c	45.4b	45.2a	52.8c	46.6a	46.8b

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 44. Effect of seeding rates on days to first flower at 4 station years

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	51.8a	52.0a	51.6a
Ellerslie	53.4a	53.2a	53.0a
1977			
Edmonton	47.4a	47.4a	47.4a
Ellerslie	48.7a	48.7a	48.7a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

regard to 1st flower at both locations and in both years (Table 42 and 43). Differences for days to first flower between the earliest line and the latest cultivar were 10 days to 2 weeks. The earliest maturing line, 74G-1382, was significantly earlier flowering than the other genotypes while the latest maturing cultivar, Oro, was significantly later flowering than the other genotypes (Table 3). Allen et al (1971) reported that one can breed to shorten the leaf growth period of rapeseed plants. Thurling (1974) reported similiar facts for growth of both species of rapeseed. Thurling also found that earlier flowering cultivars of *B. napus* in western Australia were advantageous because of rapidly decreasing soil moisture in the spring. Also, significant increases in seed yield could result from an increased rate of pre-anthesis growth.

Last flower (code 5.0)

Delayed seeding resulted in a significant decrease in days to last flower between all three seeding dates at both locations in both years (Table 45 and 46). The decrease between the 1st and 3rd seeding date of approximately 8 days in 1976 and approximately 4 days in 1977 is not enough to compensate for the seeding delay of 28 days.

Increased seeding rate resulted in a significant decrease in days to last flower in 1976 but there was no significant effect in 1977 (Table 47).

Table 45. Effects of seeding date, seeding rate and genotype on days to last flower 1976

Genotype	Rate kg/ha	Edmonton Date of seeding 1st	2nd	3rd	Ellerslie Date of seeding 1st	2nd	3rd
Oro	3	82	78	74	86	80	75
Oro	6	82	78	73	85	79	74
Oro	12	81	77	72	85	79	73
Oro means		82	78	73	85	79	74
Turret	3	74	72	69	80	74	70
Turret	6	74	71	68	79	73	69
Turret	12	74	70	66	78	72	68
Turret means		74	71	68	79	73	69
Midas	3	79	76	71	83	77	73
Midas	6	78	75	70	82	77	71
Midas	12	78	74	68	81	76	70
Midas means		78	75	70	82	77	71
74G-1382	3	71	64	62	72	67	64
74G-1382	6	70	64	60	72	66	63
74G-1382	12	70	63	59	71	65	62
74G-1382 means		70	64	60	72	66	63
73G- 438	3	74	68	66	77	71	69
73G- 438	6	74	67	65	76	70	68
73G- 438	12	74	67	64	75	69	68
73G- 438 means		74	67	65	76	70	68
Date means+		75.6c	70.9b	67.0a	78.7c	73.0b	69.1a

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 46. Effects of seeding date, seeding rate and genotype on days to last flower 1977

		Edmonton			Ellerslie		
	Rate	Date of seeding			Date of seeding		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	78	76	71	86	78	72
Oro	6	78	76	71	86	78	72
Oro	12	78	76	71	86	78	72
Oro means		78	76	71	86	78	72
Turret	3	73	70	67	74	69	68
Turret	6	73	70	67	74	69	68
Turret	12	73	70	67	74	69	68
Turret means		73	70	67	74	69	68
Midas	3	74	71	68	75	71	69
Midas	6	74	71	68	75	71	69
Midas	12	74	71	68	75	71	69
Midas means		74	71	68	75	71	69
74G-1382	3	63	61	63	63	63	64
74G-1382	6	63	61	63	63	63	64
74G-1382	12	63	61	63	63	63	64
74G-1382 means		63	61	63	63	63	64
73G- 438	3	70	66	66	70	67	66
73G- 438	6	70	66	66	70	67	66
73G- 438	12	70	66	66	70	67	66
73G- 438 means		70	66	66	70	67	66
Date means+		71.6c	68.8b	67.0a	73.6c	69.6b	67.8a

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 47. Effect of seeding rates on days to last flower at 4 station years

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	72.0c	71.2b	70.4a
Ellerslie	74.2c	73.6b	72.6a
1977			
Edmonton	69.1a	69.1a	69.1a
Ellerslie	70.3a	70.3a	70.3a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Maturity differences between genotypes were evident at last flower at both locations in both years (Tables 45 and 46). The maturity ranking of the different genotypes is well established at this time in the morphological development of *B. napus* according to the above results. Relative differences among genotypes across locations and years were fairly consistent. Actual differences between genotypes were larger in 1977 than 1976. The line 74G-1382 was significantly earlier while Oro was significantly later in reaching last flower than the other genotypes (Table 3).

Maturity of first pod (code 5.4)

Delayed seeding resulted in a significant decrease in days to maturity of first pod among all three seeding dates in 1976 at both locations and Ellerslie in 1977 (Table 48 and 49). There was no significant difference between the 1st and 3rd seeding date at Edmonton in 1977. The 2nd seeding date had a significantly greater number of days to maturity of first pod than both the 1st and 3rd seeding date (Table 49).

Increased seeding rate resulted in a significant decrease in days to maturity of 1st pod between all three seeding rates at both locations in 1976 (Table 50). Increased seeding rate from 3 to 12 kg/ha resulted in significant decreased time to maturity of 1st pod at both locations in 1977.

Table 48. Effects of seeding date, seeding rate and genotype on days to maturity of first pod 1976

		Edmonton			Ellerslie		
	Rate	Date of seeding			Date of seeding		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	114	108	102	118	112	105
Oro	6	113	107	102	116	110	104
Oro	12	110	107	100	114	108	103
Oro means		112	107	101	116	110	104
Turret	3	109	103	100	113	108	101
Turret	6	108	101	100	112	106	100
Turret	12	107	101	99	111	104	100
Turret means		108	102	100	112	106	100
Midas	3	110	102	100	115	106	101
Midas	6	109	100	99	114	104	100
Midas	12	107	99	97	113	103	99
Midas means		109	100	99	114	104	100
74G-1382	3	100	98	96	107	102	98
74G-1382	6	100	96	95	105	95	97
74G-1382	12	99	94	92	104	93	96
74G-1382 means		100	96	94	105	97	97
73G- 438	3	103	100	98	109	102	99
73G- 438	6	101	99	97	107	99	98
73G- 438	12	101	98	97	106	95	97
73G- 438 means		102	99	97	107	99	98
Date means+		106c	101b	98a	110c	103b	100a

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 49. Effects of seeding date, seeding rate and genotype on days to maturity of first pod 1977

Genotype	Rate kg/ha	Edmonton Date of seeding 1st	2nd	3rd	Ellerslie Date of seeding 1st	2nd	3rd
Oro	3	113	116	120	124	118	122
Oro	6	112	116	120	123	117	122
Oro	12	112	115	120	123	116	121
Oro means		112	116	120	123	117	122
Turret	3	110	111	107	116	113	109
Turret	6	109	111	107	115	112	109
Turret	12	109	110	107	115	112	109
Turret means		109	111	107	115	112	109
Midas	3	107	110	106	113	113	107
Midas	6	107	109	106	112	113	107
Midas	12	107	109	106	112	112	107
Midas means		107	109	106	112	113	107
74G-1382	3	100	103	99	103	105	101
74G-1382	6	100	102	99	102	105	101
74G-1382	12	100	102	99	102	104	101
74G-1382 means		100	102	99	102	105	101
73G- 438	3	104	106	102	107	109	104
73G- 438	6	104	105	102	106	109	104
73G- 438	12	104	105	102	106	108	104
73G- 438 means		104	105	102	106	109	104
Date means+		107a	109b	107a	112c	111b	109a

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 50. Effect of seeding rates on days to maturity of first pod at 4 station years

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	103c	102b	101a
Ellerslie	106c	105b	103a
1977			
Edmonton	108b	107a	107a
Ellerslie	111b	111b	110a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

The genotype rankings for maturity of 1st pod means was similar within dates at both locations in both years (Tables 48 and 49). The range from earliest to latest genotype within dates was shortest (7 days) for the last date in 1976 and the longest (20 days) for the last date in 1977. This indicates the difference that can be present between different years. The line 74G-1382 was significantly earlier for maturity of 1st pod than the three cultivars (Table 3). Oro was significantly later for maturity of 1st pod than the other genotypes.

Maturity of last pod (code 5.5)

Delayed seeding from the first to the second date of seeding at both locations in 1976 resulted in a significant decrease in the number of days to maturity of last pod (Table 51). Delayed seeding from the second to the third date at both locations resulted in a significant increased period to maturity of last pod in 1976. In 1977 at Edmonton, days to maturity of last pod increased significantly and then decreased significantly between first and second, and second and third planting date respectively while Ellerslie, 1977, had a significant decrease in days to maturity of last pod with delayed seeding between the 1st and 2nd seeding date with no change between the 2nd and 3rd seeding dates (Table 52).

All increases in seeding rate resulted in significant

Table 51. Effects of seeding date, seeding rate and genotype on days to maturity of last pod 1976

		Edmonton			Ellerslie		
	Rate	Date of seeding			Date of seeding		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	117	114	119	123	115	120
Oro	6	115	112	117	122	115	117
Oro	12	115	111	114	120	114	115
Oro means		116	112	117	122	115	117
Turret	3	115	111	116	120	113	116
Turret	6	113	110	113	119	112	114
Turret	12	112	110	111	117	111	111
Turret means		113	110	113	119	112	114
Midas	3	114	110	114	121	112	116
Midas	6	113	110	112	120	111	112
Midas	12	112	109	110	119	110	110
Midas means		113	110	112	120	111	113
74G-1382	3	109	104	105	114	109	109
74G-1382	6	108	103	102	113	105	108
74G-1382	12	107	102	100	111	103	106
74G-1382 means		108	103	102	113	106	108
73G- 438	3	110	106	110	117	110	111
73G- 438	6	109	105	107	116	108	110
73G- 438	12	108	104	104	115	106	108
73G- 438 means		109	105	107	116	108	110
Date means+		112c	108a	110b	118c	110a	112b

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 52. Effects of seeding date, seeding rate and genotype on days to maturity of last pod 1977

Genotype	Rate kg/ha	Edmonton Date of seeding 1st	2nd	3rd	Ellerslie Date of seeding 1st	2nd	3rd
Oro	3	124	126	133	136	129	125
Oro	6	123	126	133	133	129	125
Oro	12	123	125	133	133	128	125
Oro means		123	126	133	134	129	125
Turret	3	118	122	118	128	120	121
Turret	6	117	122	118	128	120	121
Turret	12	117	121	118	127	119	121
Turret means		117	122	118	128	120	121
Midas	3	117	120	117	127	119	119
Midas	6	116	119	117	126	119	119
Midas	12	116	119	117	126	118	119
Midas means		116	119	117	126	119	119
74G-1382	3	109	113	110	111	110	111
74G-1382	6	109	112	110	110	110	111
74G-1382	12	109	112	110	110	110	111
74G-1382 means		109	112	110	110	110	111
73G- 438	3	113	116	112	114	114	114
73G- 438	6	113	116	112	113	114	114
73G- 438	12	113	115	112	113	114	114
73G- 438 means		113	116	112	113	114	114
Date means+		116a	119c	118b	122b	118a	118a

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 53. Effect of seeding rates on days to maturity of last pod at 4 station years

Location	Rate of Seeding*		
	3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	112c	110b	108a
Ellerslie	115c	113b	112a
1977			
Edmonton	118a	118a	118a
Ellerslie	120b	120b	119a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

decreases in days to maturity of last pod at both locations in 1976 (Table 53). Seeding rate resulted in no change in maturity of last pod at Edmonton 1977 while Ellerslie plots indicated the 12 kg/ha seeding rate to be significantly lower than the other two seeding rates in 1977.

Differences in days to maturity of last pod were quite noticeable between the earliest line and the latest cultivar in all trials (Tables 51 and 52). Overall averages placed the early maturing lines, 74G-1382 and 73G-438, significantly earlier than the three cultivars (Table 3). The cultivar Oro was significantly later than the other genotypes. The line 74G-1382 was 13 days earlier than Oro on the average.

Time to first flower appeared to be a good indication of the time to maturity of the different genotypes. The ranking of the genotypes for 1st flower and for maturity is closely related (Tables 42, 43, 51 and 52). Thus the practice of selecting for early maturing B. napus by selecting for 1st flower is a valuable technique.

The early lines were as high seed yielding as Turret and Midas, and the latest cultivar, Oro, was significantly lower seed yielding than the other genotypes. The genotypes picked might have affected the results, especially for variables involving seed yield, flowering and maturity. The two lines were part of the plant breeding program which had used recurrent selection for a number of years with emphasis

on early flowering and high seed yield.

The maturity of last pod was important in that seed production time was defined as the period between first flower of the main raceme and maturity of last pod of the main raceme. A problem with this measurement was that the material was harvested before the maturity of last pod and the respiration rate of standing plants may be different from cut and bagged plants. The commonly used period between first flower of main raceme and maturity of first pod of the main raceme (seed formation period) was measured but because the plants were still flowering at this time and approximately 25% of seed yield had not formed, the period ending with maturity of last pod was also measured. The period between first flower and cutting time was not used for two reasons: one, there was no exact stage to identify and two, material was cut when labor and time allowed, and all material may not have been at exactly the same stage. Date of swathing had no effect on yield or oil content of _B. campestris_ or _B. napus_ in southern Alberta after seed moisture content dropped below 25% (Pittman, 1974). In a five year study at Melfort, swathing rape when the seed contained more than 45% moisture resulted in yield reductions of 400 kg/ha and about 1% lower oil and protein content (Downey _et al_, 1974). Rape should be swathed when the seeds contain about 35% moisture. At this stage the crop will usually be green brown in color, and the seeds will be firm when pressed between the fingers, and about 25% of them

will have started to turn color. In a dates of swathing experiment at Swift Current, yields of rape failed to increase after seed moisture content dropped below 28%. Swathing rape over 45% moisture resulted in yield reductions of 300 to 400 lbs per acre while late swathing (less than 20% seed moisture) results in a fluffy swath easily moved by wind, and increased shattering losses. Thus there is a certain amount of leeway within which the plant material may be cut. In this study the plot material was harvested 4 to 6 days after maturity of 1st pod was recorded.

Maturity determinations may influence the selection of experimental lines both directly, as in the selection for earliness, and indirectly, as in the selection of high seed yield and a specific quality.

Flowering period (code 4.10 to 5.0)

Delayed seeding resulted in significant but non-consistent differences in the flowering period from trial to trial (Tables 54 and 55).

Increased seeding rate caused a significant decrease in length of flowering period in 1976 but no differences in 1977 (Table 56).

An increase in the length of the flowering period did not increase the seed yield. The cultivar Oro had significantly less seed yield but did not show any

Table 54. Effects of seeding date, seeding rate and genotype on flowering period (days) 1976

Genotype	Rate kg/ha	Edmonton Date of seeding 1st	2nd	3rd	Ellerslie Date of seeding 1st	2nd	3rd
Oro	3	21	20	22	21	21	22
Oro	6	21	20	21	20	20	22
Oro	12	20	19	20	20	21	21
Oro means		21	20	21	20	21	22
Turret	3	18	20	20	20	21	20
Turret	6	17	19	19	21	20	19
Turret	12	17	18	18	19	20	18
Turret means		17	19	19	20	20	19
Midas	3	20	23	20	23	23	23
Midas	6	20	22	20	23	23	21
Midas	12	20	21	19	22	23	20
Midas means		20	22	20	23	23	21
74G-1382	3	23	16	19	21	18	19
74G-1382	6	22	16	17	21	17	18
74G-1382	12	22	15	16	20	16	17
74G-1382 means		22	16	17	21	17	18
73G- 438	3	21	17	19	22	20	20
73G- 438	6	22	16	18	21	19	20
73G- 438	12	22	17	17	20	18	19
73G- 438 means		22	17	18	21	19	20
Date means+		20.3c	18.6a	18.9b	20.8b	20.0a	19.9a

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 55. Effects of seeding date, seeding rate and genotype on flowering period (days) 1977

		Edmonton			Ellerslie		
	Rate	Date of seeding			Date of seeding		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	22	23	18	28	24	17
Oro	6	22	23	18	28	24	17
Oro	12	22	23	18	28	24	17
Oro means		22	23	18	28	24	17
Turret	3	21	25	22	21	23	22
Turret	6	21	25	22	21	23	22
Turret	12	21	25	22	21	23	22
Turret means		21	25	22	21	23	22
Midas	3	21	25	22	20	24	22
Midas	6	21	25	22	20	24	22
Midas	12	21	25	22	20	24	22
Midas means		21	25	22	20	24	22
74G-1382	3	16	22	24	15	22	23
74G-1382	6	16	22	24	15	22	23
74G-1382	12	16	22	24	15	22	23
74G-1382 means		16	22	24	15	22	23
73G- 438	3	20	22	23	20	22	21
73G- 438	6	20	22	23	20	22	21
73G- 438	12	20	22	23	20	22	21
73G- 438 means		20	22	23	20	22	21
Date means+		20.0a	23.4c	21.8b	20.8a	23.0c	21.0b

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 56. Effect of seeding rates on flowering period at 4 station years (days)

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	19.7b	19.3ab	18.7a
Ellerslie	20.9c	20.3b	19.6a
1977			
Edmonton	21.7a	21.7a	21.7a
Ellerslie	21.6a	21.6a	21.6a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

significant difference from the other genotypes in length of the flowering period (Table 3). Genotype differences were present for flowering periods but they were not consistent (Tables 54 and 55). Overall averages showed the earliest maturing line to have a significantly shorter flowering period than the cultivar Midas (Table 3).

Seed formation period (code 4.10 to 5.4)

Delayed seeding resulted in significant but non-consistent differences in the seed formation period from trial to trial (Tables 57 and 58). In 1976, the 1st seeding date had the longest seed formation time at both locations while in 1977 the second date had the longest seed formation time at both locations. This indicates that year to year effects were not as consistent as location to location effects. One could conclude that within the central Alberta region year to year evaluations at one location is better than station to station evaluations.

All increases in the seeding rate reduced significantly the length of the seed formation period (Table 59).

Genotype means within dates were all different in 1977 at both locations, while 1976 data indicate the cultivars to be more uniform in their seed formation period and some not different from others (Tables 57 and 58). Overall averages indicated no significant differences among genotypes for seed formation period (Table 3).

Table 57. Effects of seeding date, seeding rate and genotype on seed formation period (days) 1976

Genotype	Rate kg/ha	Edmonton Date of seeding 1st	2nd	3rd	Ellerslie Date of seeding 1st	2nd	3rd
Oro	3	53	50	50	53	53	52
Oro	6	52	49	50	51	51	52
Oro	12	49	49	48	49	50	51
Oro means		51	49	49	51	51	52
Turret	3	52	51	51	54	55	51
Turret	6	51	49	51	54	53	50
Turret	12	50	49	51	53	52	50
Turret means		51	50	51	53	53	50
Midas	3	52	49	49	55	52	51
Midas	6	51	47	49	55	50	50
Midas	12	49	46	48	54	50	49
Midas means		50	47	49	55	51	50
74G-1382	3	52	50	53	56	53	53
74G-1382	6	52	48	52	54	46	52
74G-1382	12	51	46	50	54	44	51
74G-1382 means		52	48	52	55	48	52
73G- 438	3	50	49	51	54	51	51
73G- 438	6	49	48	50	52	48	49
73G- 438	12	49	48	50	51	44	48
73G- 438 means		50	48	50	52	48	49
Date means+		50.8c	48.5a	50.1b	53.1c	50.1a	50.7b

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 58. Effects of seeding date, seeding rate and genotype on seed formation period (days) 1977

Genotype	Rate kg/ha	Edmonton Date of seeding 1st	2nd	3rd	Ellerslie Date of seeding 1st	2nd	3rd
Oro	3	57	63	67	66	64	67
Oro	6	56	63	67	65	63	67
Oro	12	56	62	67	65	62	66
Oro means		56	63	67	65	63	67
Turret	3	58	66	62	63	67	63
Turret	6	57	66	62	62	66	63
Turret	12	57	65	62	62	66	63
Turret means		57	66	62	62	66	63
Midas	3	54	64	60	58	66	60
Midas	6	54	63	60	57	66	60
Midas	12	54	63	60	57	65	60
Midas means		54	63	60	57	66	60
74G-1382	3	53	64	60	55	64	60
74G-1382	6	53	63	60	54	64	60
74G-1382	12	53	63	60	54	63	60
74G-1382 means		53	63	60	54	64	60
73G- 438	3	54	62	59	57	64	59
73G- 438	6	54	61	59	56	64	59
73G- 438	12	54	61	59	56	63	59
73G- 438 means		54	61	59	56	64	59
Date means+		54.9a	63.3c	61.6b	59.1a	64.4c	61.7b

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 59. Effect of seeding rates on seed formation period at 4 station years (days)

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	50.8c	49.9b	48.8a
Ellerslie	52.9c	51.1b	49.9a
1977			
Edmonton	60.2c	59.9b	59.7a
Ellerslie	62.2c	61.7b	61.4a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Seed production period (4.10 to 5.5)

Delayed seeding resulted in a significant decrease in seed production period between the 1st and 2nd seeding dates but a significant increase between the 2nd and 3rd seeding dates at both locations in 1976 (Table 60). In 1977, treatments at both locations indicated a significant increase in the seed production period when seeding was delayed from the 1st to the 2nd seeding date and then a significant but small decrease between the 2nd and 3rd seeding dates (Table 61).

Increased seeding rate resulted in a significant but small decrease in seed formation period at both locations in both years with a greater decrease being present in 1976 (Table 62).

Overall averages showed no significant differences between genotypes for the seed production period (Table 3).

Table 60. Effects of seeding date, seeding rate and genotype on seed production period (days) 1976

		Edmonton			Ellerslie		
	Rate	Date of seeding			Date of seeding		
Genotype	kg/ha	1st	2nd	3rd	1st	2nd	3rd
Oro	3	56	56	67	58	56	67
Oro	6	54	54	65	57	56	65
Oro	12	54	53	62	55	56	63
Oro means		55	54	65	57	56	65
Turret	3	58	59	67	61	60	66
Turret	6	56	58	64	61	59	64
Turret	12	55	58	63	59	59	61
Turret means		56	58	65	60	59	64
Midas	3	56	57	63	61	58	66
Midas	6	55	57	62	61	57	62
Midas	12	54	56	61	60	57	60
Midas means		55	57	62	61	57	63
74G-1382	3	61	56	62	63	60	64
74G-1382	6	60	55	59	62	56	63
74G-1382	12	59	54	58	60	54	61
74G-1382 means		60	55	60	62	57	63
73G- 438	3	57	55	63	62	59	63
73G- 438	6	57	54	60	61	57	61
73G- 438	12	56	54	57	60	55	59
73G- 438 means		57	54	60	61	57	61
Date means+		56.5b	55.7a	62.2c	60.0b	57.3a	63.0c

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 61. Effects of seeding date, seeding rate and genotype on seed production period (days) 1977

Genotype	Rate kg/ha	Edmonton Date of seeding 1st	2nd	3rd	Ellerslie Date of seeding 1st	2nd	3rd
Oro	3	68	73	80	78	75	70
Oro	6	67	73	80	75	75	70
Oro	12	67	72	80	75	74	70
Oro means		67	73	80	76	75	70
Turret	3	66	77	73	75	74	75
Turret	6	65	77	73	75	74	75
Turret	12	65	76	73	74	73	75
Turret means		65	77	73	75	74	75
Midas	3	64	74	71	72	72	72
Midas	6	63	73	71	71	72	72
Midas	12	63	73	71	71	71	72
Midas means		63	73	71	71	72	72
74G-1382	3	62	74	71	63	69	70
74G-1382	6	62	73	71	62	69	70
74G-1382	12	62	73	71	62	69	70
74G-1382 means		62	73	71	62	69	70
73G- 438	3	63	72	69	64	69	69
73G- 438	6	63	72	69	63	69	69
73G- 438	12	63	71	69	63	69	69
73G- 438 means		63	72	69	63	69	69
Date means+		64.2a	73.5c	72.8b	69.5a	71.6c	71.2b

+ seeding date comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Table 62. Effect of seeding rates on seed production period at 4 station years (days)

Locations	Rate of Seeding* 3 kg/ha	6 kg/ha	12 kg/ha
1976			
Edmonton	59.5c	58.0b	56.8a
Ellerslie	61.5c	60.1b	58.6a
1977			
Edmonton	70.4c	70.2b	70.0a
Ellerslie	70.9b	70.8ab	70.7a

* seeding rate comparisons within location, followed by the same letter are not significantly different at LSD 5% level.

Part B Correlations

Correlations among 19 variables across all replications, treatments, dates, locations and years (n = 720) were calculated (Table 63 and Appendix 1). Correlations among 19 variables across all replications, rates, dates, locations, and years with genotypes separate (n=144) were also calculated (Tables 64, 65, 66, 67, 68 and Appendix 2, 3, 4, 5, 6).

Seed yield and plant density were evaluated in relation to (A) yield components, (B) seed quality and (C) growth characters. The reason for including plant density was that it is a direct indication of the seeding rate which producers or researchers can control.

Seed yield, plant density and yield components

Correlations across all genotypes (n = 720) indicated a significant positive correlation between seed yield and total yield or harvest index and a significant negative correlation between seed yield and vegetative yield (Table 63A). This agrees with previous work which found seed yield per unit area to correlate positively with total yield and the harvest index for both species of rapeseed (Thurling, 1974c). A highly significant positive correlation between vegetative yield and total yield and a highly significant negative correlation between vegetative yield or total yield and harvest index was present. The vegetative yield is a

Table 63. Correlations among yield components, seed quality and growth characters across all genotypes for Edmonton & Ellerslie 1976 & 1977

n = 720 (.113**, .096*)

A yield components	1	2	3	4	5	6	7	8	9	10
1. seed yield										
2. vegetative yield	-.13									
3. total yield	.26	.93								
4. harvest index	.75	-.73	-.42							
5. seed yield/plant	.27	-.25	-.14	.38						
6. 1000 seed wt	.35	-.00	.13	.25	.06					
7. plant density	-.07	.17	.14	-.20	-.76	.04				
8. raceme/m²	.03	.14	.15	-.12	-.70	-.04	.83			
9. raceme/plant	.08	-.16	-.12	.18	.63	-.16	-.68	-.27		
10. plant height	-.40	.31	.15	-.49	-.08	-.60	-.07	.00	.15	

B seed yield and plant density vs quality	1	2	3	4	5
1. seed yield					
2. % seed oil	.23				
3. % meal protein	.07	-.00			
4. 1000 seed wt	.35	.19	.42		
5. plant density	-.07	-.27	.10	.04	

C seed yield and plant density vs growth characters	1	2	3	4	5	6	7	8	9
1. seed yield									
2. 1st flower	-.04								
3. last flower	-.05	.90							
4. maturity of 1st pod	-.18	.52	.67						
5. maturity of last pod	-.19	.38	.56	.91					
6. flowering period	-.05	-.10	.34	.41	.48				
7. seed formation period	-.16	.33	-.08	.63	.66	.54			
8. seed production period	-.16	-.42	-.16	.48	.68	.54	.91		
9. plant density	-.07	.02	.03	.13	.10	.02	.13	.09	

**, * significant at the 1% and 5% level respectively

Table 64. Correlations among yield components, seed quality and growth characters for Oro in Edmonton & Ellerslie 1976 & 1977

n = 144 (.252**, .213*)

A yield components	1	2	3	4	5	6	7	8	9	10
1. seed yield										
2. vegetative yield	-.18									
3. total yield	.20	.92								
4. harvest index	.83	-.67	.35							
5. seed yield/plant	.40	-.22	-.07	.44						
6. 1000 seed wt	.22	.31	.39	-.05	-.13					
7. plant density	-.15	.15	.09	-.26	-.71	.25				
8. raceme/m^2	-.01	.08	.08	-.09	-.59	.19	.78			
9. raceme/plant	.19	-.23	-.16	.31	.62	-.19	-.70	-.21		
10. plant height	-.32	.13	.01	-.29	.08	-.38	-.26	-.16	.27	

B seed yield and plant density vs quality	1	2	3	4	5
1. seed yield					
2. % seed oil	.06				
3. % meal protein	-.25	.11			
4. 1000 seed wt	.22	-.09	.10		
5. plant density	-.15	-.15	.18	.25	

C seed yield and plant density vs growth characters	1	2	3	4	5	6	7	8	9
1. seed yield									
2. 1st flower	.21								
3. last flower	.48	.80							
4. maturity of 1st pod	-.27	.19	.25						
5. maturity of last pod	-.18	-.23	.03	.81					
6. flowering period	.51	-.02	.58	.16	.37				
7. seed formation period	-.37	-.36	-.20	.85	.90	.16			
8. seed production period	-.24	-.62	-.32	.57	.90	.30	.88		
9. plant density	-.15	-.11	-.01	.23	.20	.13	.27	.21	

**, * significant at the 1% and 5% level respectively

Table 65. Correlations among yield components, seed quality and growth characters for Turret in Edmonton & Ellerslie 1976 & 1977

n = 144 (.252**, .213*)

A yield components	1	2	3	4	5	6	7	8	9	10
1. seed yield										
2. vegetative yield	-.09									
3. total yield	.28	.93								
4. harvest index	.72	-.74	-.46							
5. seed yield/plant	.20	.00	.08	.15						
6. 1000 seed wt	.49	.14	.32	.23	.30					
7. plant density	-.01	-.01	-.01	-.02	-.79	-.20				
8. raceme/m²	.16	-.05	.01	.14	-.71	-.07	.86			
9. raceme/plant	.07	.00	.03	.07	.71	.21	-.69	-.35		
10. plant height	-.40	.23	.07	-.42	-.09	-.29	-.05	-.12	-.03	

B seed yield and plant density vs quality	1	2	3	4	5
1. seed yield					
2. % seed oil	.22				
3. % meal protein	.11	-.39			
4. 1000 seed wt	.49	.09	.42		
5. plant density	-.01	-.30	-.01	-.20	

C seed yield and plant density vs growth characters	1	2	3	4	5	6	7	8	9
1. seed yield									
2. 1st flower	.14								
3. last flower	.20	.88							
4. maturity of 1st pod	.12	.10	.46						
5. maturity of last pod	.09	-.22	.11	.81					
6. flowering period	.02	-.67	-.25	.51	.62				
7. seed formation period	-.01	-.63	-.27	.71	.79	.88			
8. seed production period	-.03	-.75	-.46	.49	.81	.83	.91		
9. plant density	-.01	.19	.14	.01	-.10	-.17	-.13	-.19	

**, * significant at the 1% and 5% level respectively

Table 66. Correlations among yield components, seed quality and growth characters for Midas in Edmonton & Ellerslie 1976 & 1977

n = 144 (.252**, .213*)

A yield components	1	2	3	4	5	6	7	8	9	10
1. seed yield										
2. vegetative yield	-.00									
3. total yield	.36	.93								
4. harvest index	.69	-.71	-.42							
5. seed yield/plant	.15	-.36	-.28	.40						
6. 1000 seed wt	.38	.23	.35	.09	-.18					
7. plant density	.18	.27	.32	-.10	-.79	.23				
8. raceme/m^2	.22	.19	.26	-.01	-.73	.21	.84			
9. raceme/plant	-.06	-.29	-.30	.18	.52	-.23	-.60	.14		
10. plant height	-.36	.20	.06	-.39	-.04	-.38	-.08	.03	.19	

B seed yield and plant density vs quality	1	2	3	4	5
1. seed yield					
2. % seed oil	-.05				
3. % meal protein	-.04	-.10			
4. 1000 seed wt	.38	-.06	.19		
5. plant density	.18	-.15	.21	.23	

C seed yield and plant density vs growth characters	1	2	3	4	5	6	7	8	9
1. seed yield									
2. 1st flower	.22								
3. last flower	.21	.92							
4. maturity of 1st pod	.14	.24	.40						
5. maturity of last pod	.07	-.03	.03	.79					
6. flowering period	-.71	-.39	-.01	.33	.15				
7. seed formation period	-.05	-.56	-.37	.67	.70	.58			
8. seed production period	-.10	-.70	-.60	.40	.73	.38	.88		
9. plant density	.18	-.09	-.04	.18	.12	.12	.22	.14	

**, * significant at the 1% and 5% level respectively

Table 67. Correlations among yield components, seed quality and growth characters for 74G-1382 in Edmonton & Ellerslie 1976 & 1977

n = 144 (.252**, .213*)

A yield components	1	2	3	4	5	6	7	8	9	10
1. seed yield										
2. vegetative yield	-.03									
3. total yield	.35	.92								
4. harvest index	.68	-.74	-.44							
5. seed yield/plant	.20	-.25	-.16	.34						
6. 1000 seed wt	.50	-.20	.00	.48	.21					
7. plant density	.03	.23	.23	-.17	-.83	-.05				
8. raceme/m^2	-.04	.28	.28	-.21	-.77	-.17	.91			
9. raceme/plant	-.03	-.05	-.06	.03	.74	-.09	-.74	-.46		
10. plant height	-.31	.36	.23	-.48	.02	-.40	-.09	.04	.23	

B seed yield and plant density vs quality	1	2	3	4	5
1. seed yield					
2. % seed oil	.09				
3. % meal protein	.12	-.43			
4. 1000seed wt	.50	.06	.25		
5. plant density	.03	-.28	-.01	-.05	

C seed yield and plant density vs growth characters	1	2	3	4	5	6	7	8	9
1. seed yield									
2. 1st flower	.23								
3. last flower	-.11	.65							
4. maturity of 1st pod	.21	-.03	.37						
5. maturity of last pod	.08	-.20	.30	.88					
6. flowering period	-.41	-.58	.25	.43	.57				
7. seed formation period	-.03	-.75	-.22	.68	.73	.71			
8. seed production period	-.11	-.81	-.27	.54	.73	.74	.95		
9. plant density	.03	-.04	-.07	-.03	-.01	-.02	.01	.03	

**, * significant at the 1% and 5% level respectively

Table 68. Correlations among yield components, seed quality and growth characters for 73G-438 in Edmonton & Ellerslie 1976 & 1977

n = 144 (.252**, .213*)

A yield components	1	2	3	4	5	6	7	8	9	10
1. seed yield										
2. vegetative yield	.07									
3. total yield	.41	.94								
4. harvest index	.64	-.70	-.42							
5. seed yield/plant	.19	-.34	-.24	.44						
6. 1000 seed wt	.10	.39	.39	-.23	-.10					
7. plant density	-.14	.20	.13	-.32	-.72	.16				
8. raceme/m²	-.05	.14	.11	-.20	-.73	.09	.84			
9. raceme/plant	.09	-.33	.27	.35	.61	-.21	-.66	-.29		
10. plant height	-.28	.14	.03	-.30	-.00	-.46	-.12	-.17	-.02	

B seed yield and plant density vs quality	1	2	3	4	5
1. seed yield					
2. % seed oil	.08				
3. % meal protein	-.10	-.22			
4. 1000 seed wt	.10	-.20	.55		
5. plant density	-.14	-.40	.25	.16	

C seed yield and plant density vs growth characters	1	2	3	4	5	6	7	8	9
1. seed yield									
2. 1st flower	.18								
3. last flower	.10	.86							
4. maturity of 1st pod	.03	-.05	.29						
5. maturity of last pod	-.12	-.20	.20	.86					
6. flowering period	-.17	-.41	-.12	.61	.72				
7. seed formation period	-.09	-.70	-.36	.75	.74	.71			
8. seed production period	-.19	-.77	-.43	.59	.77	.73	.94		
9. plant density	-.14	-.14	-.06	.20	.20	.16	.23	.22	

**, * significant at the 1% and 5% level respectively

major component of total yield and therefore has a large impact on the harvest index. What was important, was the significant negative correlation between seed yield and vegetative yield. Also important was the significant positive correlation between seed yield and harvest index over all genotypes which would indicate breeders could use harvest index to evaluate breeding material. These correlations with vegetative yield and harvest index support the concept of breeding of dwarf and semi-dwarf plant types, that is material shorter in height with compact racemes which have a low vegetative yield while having a high harvest index and high seed yield.

In contrast to the overall negative correlation between seed yield and vegetative yield, 4 out of 5 genotypes showed no significant relationship between them (Tables 64A, 65A, 66A, 67A, and 68A). There was a significant positive correlation between seed yield and total yield in 4 out of 5 genotypes which agrees with the correlations across all genotypes. Harvest index correlated significantly and positively with seed yield for all 5 genotypes as it did across all genotypes. Extremely high positive correlations were present between vegetative yield and total yield for all 5 genotypes while a highly significant negative correlation was present between vegetative yield and harvest index for all 5 genotypes. These relations between vegetative yield and total yield or harvest index were the same over all genotypes and expected because vegetative

yield is the major part of total yield. Four out of the 5 genotypes had highly significant negative correlations between total yield and harvest index, this was also the case across all genotypes, while one genotype had a highly significant positive correlation between total yield and harvest index. One explanation of this is that the late maturing cultivar Oro which had the positive correlation between total yield and harvest index, is not completing seed production under central Alberta conditions. However, the more seed production, the more total yield and the resulting ratio gives a higher positive harvest index.

Seed yield was significantly and positively correlated with the 1000 seed wt and seed yield/plant, overall 720 observations (Table 63A). The significant negative correlation between seed yield and plant height would disagree with work on single plants of B. napus which found larger plants had greater seed yield (Campbell and Kondra, 1977). This difference may have been the results of plant density differences or genotype differences between the studies. Seed yield had no correlation to plant density, racemes/m^2 and racemes/plant over all 720 observations. Seed yield/plant had a significant negative relationship with plant density and racemes/m^2 and a significant positive relationship with racemes/plant across genotypes. Plant density had a highly significant positive correlation with racemes/m^2 and a highly significant negative correlation with racemes/plant across genotypes. Ramanujam and Rai,

1963, working with *B. campestris* obtained similiar results; significant positive correlation between seed yield/area, racemes/plant and 1000 seed wt while a negative correlation was found between 1000 seed wt and racemes/plant.

There was a consistent significant negative relationship between seed yield and plant height within individual genotypes which agreed with the overall correlation (Table 64, 65, 66, 67, and 68). This indicates that one could improve present cultivars by the selection of shorter plants within any one genotype since the shorter plants resulted in higher seed yield. This supports the breeding of dwarf and semi-dwarf lines as did the negative correlation between seed yield and vegetative yield. Also, as expected there was a highly significant positive correlation between plant height and vegetative yield. Individual genotypes had a consistent significant positive correlation between seed yield and 1000 seed wt or seed yield/plant. The different genotypes had no consistent relationship between seed yield and plant density, racemes/m^2 or racemes/plant. Racemes/m^2 did not correlate with seed yield over all genotypes or for any of the genotypes separately.

Plant height had a significant negative correlation with harvest index and 1000 seed wt over all genotypes and also for each genotype separately (Tables 63, 64, 65, 66, 67, and 68). The negative correlation between plant height

and harvest index is understandable in that plant height correlated positively with vegetative yield and total yield. The negative correlation between plant height and 1000 seed wt is also understandable in that plant height correlated negatively with seed yield or harvest index and seed yield correlated positively with harvest index or 1000 seed weight. Also 1000 seed wt correlated positively with harvest index. One could infer that shorter plants transfer more nutrients into seed size production than vegetative growth. Racemes/plant had a significant positive correlation with seed yield/plant over all genotypes and also for each genotype separately. This was expected in that more racemes on a plant should mean more seed yield/plant. Working with single plants of B. juncea, seed yield/plant was found to correlate positively with racemes/plant (Singh and Singh, 1972), which is in agreement with the above data. Also present was a significant negative correlation between seed yield/plant and vegetative yield. Previous work on single plants found a high positive correlation between vegetative yield/plant and seed yield/plant in B.napus (Campbell and Kondra, 1977). These two findings disagree in that seed yield/area was negatively correlated with vegetative yield and seed yield/plant was positively correlated to vegetative yield.

Different genotypes had different factors which were major contributors to their seed yield according to correlations (Tables 64, 65, 66, 67, and 68). Of the yield

components studied, the seed yield/plant was the major contributor to seed yield for Oro while 1000 seed wt was the major contributor to seed yield for Turret and 74G-1382. One thousand seed wt and racemes/m² were the major contributors to seed yield for Midas. No high correlations were evident between seed yield and any of the yield components for 73G-438.

Plant density over 720 observations had no relationship with yield (seed, vegetative or total), 1000 seed wt or plant height, and a significant negative correlation between plant density and seed yield/plant, harvest index or racemes/plant over all genotypes was found. Plant density was significantly and positively correlated to racemes/m² over all genotypes, which was expected. Plant density is a direct indication of seeding rate. Any variable that correlates highly one way or the other with plant density is affected by seeding rate. On individual genotypes there was a consistent significant positive relationship between plant density and racemes/unit area, but as with correlations across genotypes this is expected. Consistent for all genotypes, were highly significant negative correlations between plant density and seed yield/plant or racemes/plant, which is in agreement with the overall correlations. Only the cultivar Oro had a significant negative correlation between plant density and plant height. The other genotypes had non-significantly low correlations between plant density and plant height as was the case with genotypes overall.

Seed yield, plant density and seed quality components

Over all genotypes, seed yield was significantly and positively correlated with % seed oil and 1000 seed wt (Table 63B). Plant density over all genotypes showed a significant but low positive correlation with % meal protein, and a significant negative correlation with % seed oil. The positive relationship between protein and plant density was unexpected. High plant density should result in more competition and therefore less nitrogen available to each plant for protein production. A significant positive correlation was present between % seed oil and 1000 seed wt over all genotypes. It is generally considered that large seeds will have a high oil content for two reasons. The number of cells in small or large seeds are equal, so larger seeds should have larger oil vacuoles and greater % seed oil. Also the hull to seed ratio is lower in larger seeds.

Individual genotypes across 144 observations showed a non-significant correlation between seed yield and % seed oil except for the cultivar Turret which had a significant positive correlation (Tables 64, 65, 66, 67 and 68). Turret's correlation was similar to the correlation across all genotypes between seed yield and % seed oil. Seed yield did not have any significant correlation with % meal protein for 4 out of 5 genotypes. Also, seed yield did not correlate significantly with % meal protein across all genotypes. The seed yield of Oro was significantly and negatively

correlated with % meal protein. One thousand seed wt had a consistent positive correlation with % meal protein for the different genotypes. There was no relationship between 1000 seed wt and % seed oil for any of the genotypes which was different from the positive correlations between % seed oil and 1000 seed wt across all genotypes. Plant density was negatively related to % seed oil for all 5 genotypes as was the case over all genotypes.

Correlations across all genotypes indicated no relationship between % seed oil and % meal protein, so an increased seed oil and meal protein content would be possible for certain genotypes (Table 63B). Correlations between % seed oil and % meal protein indicated that genotypes high in both oil and protein had a negative correlation between them. So a gain in % seed oil and % meal protein for the genotypes Turret, 74G-1382 and 73G-438 would be difficult, since an increase in one will likely result in a decrease in the other.

Seed yield, plant density and growth characters.

Over all genotypes, seed yield correlated negatively with all the growth characters studied (Table 63C). Of these, the significant correlations were between seed yield and maturity of 1st pod, maturity of last pod, seed formation, and seed production period. This agrees with the observations that earliness of growth stages associated with

earlier maturity resulted in higher seed yield/plant (Campbell and Kondra, 1978a). This disagrees with the work on B. juncea , which showed a positive correlation between days to flowering and seed yield/plant (Singh and Singh, 1972). None of the genotypes had the same correlation pattern between seed yield and growth characters as the correlations over all genotypes (Tables 64C, 65C, 66C, 67C, and 68C). There was a significant positive correlation between seed yield and 1st flower for 3 out of 5 genotypes. Oro had the greatest number of significant correlations between seed yield and growth characters (Table 64C). Oro was the only genotype to have a significant negative correlation between seed yield and seed formation or seed production, which agrees with the correlations across all genotypes. Midas and 74G-1382 had a significant negative correlation between seed yield and flowering period, while Oro had a significant positive correlation between seed yield and flowering period. The relationship between seed yield and growth characters of genotypes may be important with respect to their area of adaptation relative to their agroclimatic area.

First flower and maturity of 1st pod are two commonly used indicators of maturity in rapeseed. First flower was highly significantly positively correlated over all genotypes with last flower, maturity of 1st pod, and maturity of last pod (Table 63C). Across 720 observations, all correlations between maturity of 1st pod and the other

growth characters were positive and highly significant. Similarly, a number of growth stages were positively correlated to the next growth stage. This agrees with an earlier observation that the earliness of one growth stage was found to affect subsequent growth stages when working with single plants of B. napus (Campbell and Kondra, 1978a). Across all genotypes a significant positive correlation between 1st flower and maturity of 1st pod was found. Across 144 observations, with genotypes separate, only the cultivar Midas had a significant positive correlation between 1st flower and maturity of 1st pod. There was a significant positive correlation between plant height and the different growth stages (Appendix 1).

Plant density correlated significantly and positively with maturity of 1st pod, maturity of last pod, seed formation period and seed production period over all genotypes (Table 63C). Plant density did not correlate with 1st flower, last flower or flowering period. Across 144 observations, the plant density did not correlate with any of the growth stages or growth periods for the genotypes Turret or 74G-1382 (Tables 65C and 67C). The genotype Oro showed similar positive correlations between plant density and growth periods to the correlations across all genotypes. Midas and 73G-438 showed similar significant positive correlation values between plant density and seed formation period. The line 73G-438 also had a significant positive correlation value between plant density and the seed

production period. The different genotypes had different correlation patterns between plant density and growth characters.

V SUMMARY AND CONCLUSIONS

Within station years there was no significant date by treatment interaction for seed yield and vegetative yield. Delayed seeding resulted in a non-consistent effect on seed yield when comparing station years but on the average the 3rd seeding date (late seeding) resulted in the lowest seed yield. The seeding of *B. napus* in central Alberta on or before mid-May should produce the highest seed yield and earliest maturity. Delayed seeding resulted in a non-consistent effect when comparing station years for vegetative and total yield. The total yield was greatly affected by the vegetative yield. The harvest index responded in an inverse direction to vegetative or total yield. This was supported by the correlation data. Delayed seeding resulted in decreased seed yield/plant, decreased 1000 seed wt, and decreased plant density. The decrease in plant density was unexpected. Later seeding should provide warmer soil conditions and therefore better germination and more plants. However, a high micro-organism activity could result in less survival of germinating seedlings. Racemes/plant, racemes/m², and plant height means were not affected consistently by delayed seeding. Racemes/unit area were lowest for the last date of seeding at both locations in both years and therefore may partly explain lower seed yield of late seeding. However, the correlation data indicated that racemes/m² did not correlate to seed yield. Delayed seeding resulted in a slightly increased oil and

meal protein content over all. Delayed seeding resulted in decreased days to initiation of elongation, 1st flower, last flower, maturity of 1st pod and maturity of last pod. Delayed seeding decreased days to maturity on the average but not enough to compensate for the delay of 14 days between dates. The growth periods, flowering, seed formation, and seed production, were not affected consistently by delayed seeding when comparing the different station years. It appears that with later maturing cultivars, the seed production period increases more with late seeding while those of early lines increase less or remain the same with late seeding. This indicates that late maturing cultivars when seeded late are at a disadvantage because their seed production period increases which results in a greater maturity requirement and greater risk of frost. Also, one may infer that seed yield is reduced because seed production takes place during the cooler fall weather.

Increased seeding rate had no significant effect on seed yield but overall averages indicated the 6 kg/ha seeding rate to be slightly higher seed yielding. Vegetative and total yield showed a slight non-significant increase with increased seeding rate. Consequently, harvest index showed a slight non-significant decrease with increased seeding rate. This was supported by the correlation data since plant density had no correlation with yield (seed, vegetative, or total). Plant density and harvest index correlated significantly and negatively with each other

which should indicate a decrease in harvest index with increased seeding rate. Increased seeding rate did not affect the 1000 seed wt, % seed oil, % meal protein, initiation of elongation or 1st flower. Increased seeding rate resulted in the anticipated increase in plant density and racemes/m^2. The decrease in racemes/plant and seed yield/plant were also expected. The decrease was probably due to greater plant competition. These effects were supported by the correlation data. Plant height decreased with increased seeding rate. However, there was no significant correlation between plant density and plant height. Days to last flower, maturity of 1st and last pod, and length of seed formation and seed production periods decreased with increased seeding rate. Seeding rate had virtually no effect on growth stages up to and including 1st flower. The highest seeding rate resulted in a slight reduction in the days to growth stages subsequent to 1st flower.

Seed yield showed significant differences between genotypes for dates and station years but these were not consistent except for the cultivar Oro which was consistently low seed-yielding. Averages indicated the line 74G-1382 to be 20% higher seed-yielding and 2 weeks earlier than the cultivar Oro. High seed yield with early maturity would be of great benefit. The early maturing lines showed indications of being lower in vegetative yield. Total yield was not significantly different between genotypes. The early

lines were slightly lower in total yield. The harvest index was higher for the early maturing lines than the three later maturing cultivars. The correlations between seed yield, vegetative yield, total yield, and harvest index indicated the large effect vegetative yield has on total yield and therefore its impact on calculated harvest indices.

Seed yield/plant was affected by racemes/m^2, plant density, racemes/plant, plant height and 1000 seed wt . The problem with most of the yield component studies on single plants is that what contributes to yield on a single plant basis is not necessarily meaningful on a plot area basis because of competition between plants. The number of racemes/plant did not appear to be related to seed yield. Oro had the largest raceme number per plant and was relatively tall compared to the other genotypes but did not have high seed yield. Genotype differences for racemes/m^2 across all treatments were non-significant. This indicates that the number of plants or number of racemes are not major factors of seed yield/unit area. The data would indicate that within one genotype racemes/m^2 is important to seed yield but across all genotypes racemes were not a major factor. Actual pod number and seed number per pod (pod size) are two components of seed yield which should be studied.

Time to first flower seems to be a good indicator of maturity of 1st pod or maturity of last pod in B. napus since the ranking of the genotypes within a date did not

change between the growth stages. Plant height means were associated with maturity means in that the short plants were early maturing and the tall plants late maturing. This was supported by significant and positive correlations between plant height and days to different growth stages. Seed yield was non-significantly but negatively correlated with days to all growth stages. The early maturing lines had seed yield as high if not higher than the later maturing cultivars. Therefore, within a maturity range of 21 days the earliest line may have the highest yield. This implies that the generally accepted genetic association between late maturity and high seed yield can be broken by appropriate breeding and selection.

It was expected that genotypes which are high yielding would have long flowering, seed formation, and seed production periods while low yielding genotypes would have short flowering, seed formation, and seed production periods. Flowering, seed formation and seed production periods did not give the same ranking of genotype means as seed yield, so these can not be used to evaluate different genotypes for seed yield. The correlation data found no relationship between seed yield and the different growth periods. Since there appears to be no direct relationship between these growth periods and seed yield, one should be able to reduce the length of growth periods. This should reduce total days to maturity and still maintain seed yield.

The line 74G-1382 is better adapted for central Alberta conditions, primarily due to its earlier maturity, than the other genotypes. It is significantly better than the latest cultivar Oro. The line 74G-1382 had high seed yield, the highest harvest index, largest 1000 seed wt, and high oil and meal protein content, while having the lowest vegetative yield, fewest racemes/plant, fewest racemes/m^2 and the shortest plant height. The line 74G-1382 was the first to reach any of the growth stages. It had a determinate flowering pattern which was evident because it had the shortest flowering period. A determinate flowering pattern is characterized by more of the racemes flowering at the same time. Plant breeders could evaluate breeding material using some of the characteristics of 74G-1382 as a model and make valuable gains in a breeding program of *B. napus* .

Correlations across all tests ($n = 720$) indicated a significant positive correlation between seed yield and total yield or harvest index, a highly significant positive correlation between total yield and vegetative yield, and a highly significant negetative correlation between harvest index and vegetative yield or total yield. The vegetative yield is a major contributor to total yield and therefore has a great effect on calculated harvest index. Plant breeders may wish to develop a vegetative-harvest index for evaluating breeding material in an early maturing high seed yielding program. A vegetative-harvest index would be defined as seed yield over vegetative yield. Seed yield was

positively correlated with the yield components 1000 seed wt and seed yield/plant, and negatively correlated with plant height over all 720 observations. Plant height had a negative correlation with harvest index over all and also for each genotype separately. Selection of shorter plants within present cultivars may be an advantageous means of achieving seed yield gains. Shorter plants had higher harvest indices, lower vegetative yield, and higher seed yield than taller plants. This may be as a result of more nutrients being used in the production of seed yield rather than vegetative yield. There was no significant correlation between % seed oil and % meal protein except for the genotypes high in both % seed oil and % meal protein. A significant negative correlation was present for these genotypes. There was no relationship between 1000 seed wt and % seed oil.

This study found many characteristics which may be helpful in the breeding of high seed yielding and early maturing cultivars of rapeseed for central and northern Alberta. Small plants (short, few racemes and low vegetative yield) were high seed yielding and early maturing. Therefore, selection of smaller plants within cultivars or breeding material could be advantageous. Selection for high harvest index could also be used in the development of early maturity with high seed yield. There was no significant relationship between seed yield and time to growth stages or length of growth periods. Therefore, a reduction of the

total number of days from seeding to maturity without a reduction of seed yield should be possible. Raceme number per plant was not correlated to seed yield. Therefore, the pod number per raceme and seed number per pod may be major yield factors which should be studied.

The flowering period was not directly related to seed yield in this study. However, the determinate flowering pattern of 74G-1382 demonstrated that it is well suited to central Alberta. Therefore, the flowering rate should be studied to determine the relationship among flowering patterns, seed yield and maturity. Also, the rate of dry matter accumulation during the vegetative and reproductive phases may be related to seed yield and maturity. If not related the selection of earlier flowering genotypes in *B. napus* could reduce the vegetative phase and further help in achieving early maturity with high seed yield.

The immediate goal is higher seed yielding *B. napus* cultivars with a maturity requirement approaching that of *B. campestris* . The *B. napus* cultivars have higher oil content, higher meal protein content, are more disease resistant and have less management problems than *B. campestris* . Therefore, the lower seed yielding *B. campestris* cultivars could be replaced by the more desirable *B. napus* cultivars.

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Appendix 1. Correlations among all variables across all genotypes for Edmonton & Ellerslie 1976 & 1977

n = 720 (.113**, .096*)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. seed yield																			
2. total yield	.26																		
3. % seed oil	.23	-.17																	
4. 1000 seed wt	.35	.13	.19																
5. racemes/plant	.08	-.12	.18	-.16															
6. plant density/m²	-.07	.14	-.27	.04	.58														
7. plant height	-.40	.15	-.27	.60	.15	-.07													
8. maturity of 1st pod	-.18	.34	-.39	-.19	.04	.13	.49												
9. maturity of last pod	-.19	.39	-.37	.17	.03	.10	.46	.91											
10. 1st flower	-.04	-.19	-.18	-.56	.17	.02	.45	.52	.38										
11. last flower	-.05	-.05	-.28	-.56	.20	.03	.53	.67	.56	.90									
12. % meal protein	.07	.10	-.00	.42	-.18	.10	-.34	-.28	-.24	-.59	-.59								
13. seed production period	-.16	.53	-.22	.27	-.11	.09	.09	.48	.68	.42	-.16	.24							
14. harvest index	.75	-.42	.36	.25	.18	-.20	-.49	.42	-.48	.08	-.05	-.00	-.53						
15. flowering period	-.05	.29	-.26	-.06	.08	.02	.26	.41	.48	-.10	.34	-.08	.54	-.29					
16. racemes/m²	.03	.15	-.23	-.04	-.27	.83	.00	.19	.14	.15	.17	-.02	.02	-.12	.08				
17. seed yield/plant	.27	-.14	.30	.06	.63	-.76	-.08	-.18	-.14	-.03	-.05	.02	-.11	.38	-.04	-.70			
18. seed formation period	-.16	.54	-.27	.30	-.11	.13	.14	.63	.66	-.33	-.08	.22	.91	-.53	.54	.08	-.17		
19. vegetative yield	-.12	.93	-.27	-.00	-.16	.17	.31	.42	.48	-.18	-.03	.08	.61	-.73	.32	.14	-.25	.62	

**, * significant at the 1% and 5% level respectively

Appendix 2. Correlations among all variables for Oro in Edmonton & Ellerslie 1976 & 1977

n = 144 (.252**, .213*)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. seed yield																			
2. total yield	.20																		
3. % seed oil	.06	-.06																	
4. 1000 seed wt	.22	.39	-.09																
5. racemes/plant	.19	-.16	.13	-.19															
6. plant density/m²	-.15	.09	-.15	.25	-.70														
7. plant height	-.32	.01	-.04	-.38	.27	-.26													
8. maturity of 1st pod	-.27	.42	-.21	.42	-.11	.23	.23												
9. maturity of last pod	-.18	.49	-.18	.49	-.17	.20	.01	.81											
10. 1st flower	.21	-.28	-.07	-.14	.28	-.11	.28	.19	-.23										
11. last flower	.48	-.24	-.17	.10	.21	-.01	.00	.25	.03	.80									
12. % meal protein	-.25	.06	.11	.10	-.12	.18	.02	.15	.23	-.24	-.18								
13. seed production period	-.24	.52	-.11	.46	-.26	.21	-.11	.57	.90	-.62	-.32	.29							
14. harvest index	.83	-.35	.11	-.05	.31	-.26	-.29	-.50	-.47	.38	.58	-.30	-.55						
15. flowering period	.51	-.03	-.19	.35	-.03	.13	-.38	.16	.37	-.02	.58	-.03	.30	.46					
16. racemes/m²	-.01	.08	-.13	.19	-.21	.78	-.16	.17	.10	.05	.12	.16	.05	-.09	.12				
17. seed yield/plant	.40	-.07	.14	-.13	.62	-.71	.08	-.25	-.16	.13	.19	-.11	-.18	.44	.14	-.59			
18. seed formation period	-.37	.55	-.16	.47	-.25	.27	.07	.85	.90	-.36	-.20	.28	.88	-.68	.16	.13	-.31		
19. vegetative yield	-.18	.92	-.09	.31	-.23	.15	.13	.53	.56	-.36	-.42	.16	.61	-.67	-.22	.08	-.22	.69	

**, * significant at the 1% and 5% level respectively

Appendix 3. Correlations among all variables for Turret in Edmonton & Ellerslie 1976 & 1977

n = 144 (.252**, .213*)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. seed yield																			
2. total yield	.28																		
3. % seed oil	.22	-.31																	
4. 1000 seed wt	.49	.32	.09																
5. racemes/plant	.07	.03	.19	.21															
6. plant density/m²	-.01	-.01	-.30	-.20	-.69														
7. plant height	-.40	.07	-.11	-.29	-.03	-.05													
8. maturity of 1st pod	.12	.26	-.25	.48	.08	.01	.06												
9. maturity of last pod	.09	.36	-.29	.58	.18	-.10	.02	.81											
10. 1st flower	.14	-.55	.29	-.24	-.08	.19	-.03	.10	-.22										
11. last flower	.20	-.37	.10	-.01	-.02	.14	.05	.46	.11	.88									
12. % meal protein	.11	.50	-.39	.42	.05	-.01	-.03	.34	.55	-.49	-.22								
13. seed production period	-.03	.57	-.37	.53	.17	-.19	.03	.49	.81	-.75	-.46	.67							
14. harvest index	.72	-.46	.45	.23	.07	-.02	-.42	-.10	-.19	.53	.44	-.26	-.45						
15. flowering period	.02	.54	-.44	.49	.14	-.17	.15	.51	.62	-.67	-.25	.66	.83	-.40					
16. racemes/m²	.16	.01	-.28	-.07	.-35	.86	-.12	.10	.01	.26	.24	.04	-.15	.14	-.15				
17. seed yield/plant	.20	.08	.30	.30	.71	-.79	-.09	.07	.17	-.13	-.06	.02	.19	.15	.18	-.71			
18. seed formation period	-.01	.59	-.40	.55	.13	-.13	.07	.71	.79	-.63	-.27	.62	.91	-.45	.88	-.11	.14		
19. vegetative yield	-.09	.93	-.40	.14	.00	-.01	.23	.22	.34	-.62	-.46	.47	.60	-.74	.55	-.05	.00	.61	

**, * significant at the 1% and 5% level respectively

Appendix 4. Correlations among all variables for Midas in Edmonton & Ellerslie 1976 & 1977

n = 144 (.252**, .213*)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. seed yield																			
2. total yield	.36																		
3. % seed oil	-.05	-.07																	
4. 1000 seed wt	.38	.35	-.06																
5. racemes/plant	-.06	-.30	-.04	-.23															
6. plant density/m²	.18	.32	-.15	.23	-.60														
7. plant height	-.36	.06	-.02	-.38	.19	-.08													
8. maturity of 1st pod	.14	.30	-.20	.38	.08	.18	.15												
9. maturity of last pod	.07	.35	-.22	.48	.01	.12	.02	.79											
10. 1st flower	.22	-.38	.09	-.21	.37	-.09	.11	.24	-.03										
11. last flower	.21	-.31	-.02	-.18	.37	-.04	.23	.40	.03	.92									
12. % meal protein	-.04	.27	-.10	.19	-.38	.21	-.06	.06	.26	-.51	-.43								
13. seed production period	-.10	.51	-.22	.48	-.24	.14	-.06	.40	.73	-.70	-.60	.53							
14. harvest index	.69	-.42	.04	.09	.18	-.10	-.39	-.14	-.23	.52	.44	-.26	-.52						
15. flowering period	-.07	.25	-.30	.11	-.08	.12	.28	.33	.15	-.39	-.01	.30	.38	-.30					
16. racemes/m²	.22	.26	-.22	.21	-.14	.84	-.03	.29	.19	.12	.16	.00	.05	-.01	.08				
17. seed yield/plant	.15	-.28	.19	-.18	.52	-.79	-.04	-.22	-.18	.18	.12	-.21	-.25	.40	-.18	-.73			
18. seed formation period	-.05	.55	-.24	.48	-.22	.22	.05	.67	.70	-.56	-.37	.44	.88	-.52	.58	.15	-.32		
19. vegetative yield	-.00	.93	-.06	.23	-.29	.27	.20	.27	.35	-.50	-.42	.30	.58	-.71	.30	.19	-.36	.61	

**, * significant at the 1% and 5% level respectively

Appendix 5. Correlations among all variables for 74G-1382 in Edmonton & Ellerslie 1976 & 1977

n = 144 (.252**, .213*)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. seed yield																			
2. total yield	.35																		
3. % seed oil	.09	-.45																	
4. 1000 seed wt	.50	.00	.06																
5. racemes/plant	-.03	-.06	.13	-.09															
6. plant density/m²	.03	.23	-.28	-.05	-.74														
7. plant height	-.31	.23	-.20	-.40	.23	-.09													
8. maturity of 1st pod	.21	.33	-.30	.16	.16	-.03	.27												
9. maturity of last pod	.08	.45	-.38	.08	.12	-.01	.36	.88											
10. 1st flower	.23	-.34	.50	-.12	.06	-.04	-.15	-.03	-.20										
11. last flower	-.11	-.08	.26	-.36	.23	-.07	.32	.37	.30	.65									
12. % meal protein	.12	.32	-.43	.25	-.02	-.01	-.02	.01	.06	-.49	-.61								
13. seed production period	-.11	.50	-.57	.13	.03	.03	.32	.54	.73	-.81	-.27	.38							
14. harvest index	.68	-.44	.45	.48	.03	-.17	-.48	-.07	-.29	.48	-.06	-.13	-.50						
15. flowering period	-.41	.35	-.35	-.23	.17	-.02	.53	.43	.57	-.58	.25	-.02	.74	-.67					
16. racemes/m²	-.04	.28	-.29	-.17	-.46	.91	.04	.02	.03	.00	.04	-.04	.01	-.21	.04				
17. seed yield/plant	.20	-.16	.24	.21	.74	-.83	.02	.12	.04	.12	.09	.06	-.06	.34	-.05	-.77			
18. seed formation period	-.03	.47	-.56	.19	.06	.01	.29	.68	.73	-.75	-.22	.37	.95	-.40	.71	.01	-.00		
19. vegetative yield	-.03	.92	-.52	-.20	-.05	.23	.36	.27	.44	-.46	-.04	.30	.58	-.74	.54	.28	-.25	.51	

**, * significant at the 1% and 5% level respectively

Appendix 6. Correlations among all variables for 73G-438 in Edmonton & Ellerslie 1976 & 1977

n = 144 (.252**, .213*)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. seed yield																			
2. total yield	.41																		
3. % seed oil	.08	-.28																	
4. 1000 seed wt	.10	.39	-.20																
5. racemes/plant	.09	-.27	.37	-.21															
6. plant density/m²	-.14	.13	-.40	.16	-.66														
7. plant height	-.28	.03	.05	-.46	-.02	-.12													
8. maturity of 1st pod	.03	.26	-.53	.36	-.09	.20	-.01												
9. maturity of last pod	.12	.32	-.55	.39	-.17	.20	.13	.86											
10. 1st flower	.18	-.47	.10	-.63	.27	-.14	.03	-.05	-.20										
11. last flower	.10	-.28	-.06	-.52	.20	-.06	.16	.29	.20	.86									
12. % meal protein	-.10	.23	-.22	.55	-.31	.25	.20	.11	.28	-.46	-.50								
13. seed production period	-.19	.51	-.42	.66	-.29	.22	.06	.59	.77	-.77	-.43	.48							
14. harvest index	.64	-.42	.36	-.23	.35	-.32	-.30	-.24	-.43	.55	.31	-.31	-.63						
15. flowering period	-.17	.39	-.30	.31	-.17	.16	.21	.61	.72	-.41	.12	.01	.73	-.51					
16. racemes/m²	-.05	.11	-.26	.09	-.29	.84	-.17	.23	.15	.01	.09	.03	.09	-.20	.15				
17. seed yield/plant	.19	-.24	.37	-.10	.61	-.72	.00	-.25	-.23	.16	.01	-.07	-.25	.44	-.29	-.73			
18. seed formation period	.09	.50	-.44	.68	-.25	.23	-.03	.75	.74	-.70	-.36	.38	.94	-.53	.71	.15	-.28		
19. vegetative yield	.07	.94	-.33	.39	-.33	.20	.14	.27	.39	-.58	-.35	.29	.63	-.70	.50	.14	-.34	.58	

**, * significant at the 1% and 5% level respectively